Thesis/
Reports
Hall,
T.E.

Monitoring Encounters In Wilderness

FINAL REPORT FOR RESEARCH JOINT VENTURE AGMT
#INT-90532-RJVA with
OREGON STATE UNIVERSITY
FS Contact: Alan Watson
Co-op Contact: Bo Shelby

MONITORING ENCOUNTERS IN WILDERNESS

REPORT SUBMITTED TO INTERMOUNTAIN RESEARCH STATION

May 10, 1993

TROY HALL AND BO SHELBY
OREGON STATE UNIVERSITY

RJVA #INT-90532-RJVA

TABLE OF CONTENTS

INTRODUCTION 1
REVIEW OF RESEARCH 2
  A. Defining encounters 2
  B. Methods of measuring encounters 5
    Measuring perceived encounters 6
    Indirect predictors of encounters 8
    Direct measures of encounters 9
    Comparability among methods 12
    Sampling concerns 13
OBJECTIVES OF THE STUDY 14
METHODS 15
  A. Study areas 15
  B. Methods of data collection 16
    1. Encounters
      i.) Trailhead questionnaires. 18
      ii.) Wilderness Rangers 19
      iii.) Mailback surveys 20
      iv.) Trained observers 21
      v.) Trip diaries 21
    2. Shadowing 22
    3. Use levels 23
RESULTS AND DISCUSSION 24
  1. Response rates, data quality, and costs 24
    i.) Trailhead questionnaires 25
    ii.) Wilderness rangers 28
    iii.) Trained observers. 29
    iv.) Diaries 30
    v.) Mailback surveys. 30
  2. What encounter rates were generated by each method? 31
    i.) Traveling encounters 31
    ii.) Campsite encounters 36
  3. How can these results be used to evaluate compliance with Forest Plan standards? 38
  4. What is the relationship between encounters and use levels? 39
  5. How much variability is there between areas? 44
  6. What is the relationship between actual and reported encounters? 46
  7. How much time should one spend to get an accurate estimate of encounter 48
CONCLUSIONS 51
REFERENCES CITED 56
TABLES 60

INTRODUCTION

Wilderness managers are placing increasing emphasis on monitoring the physical conditions and recreational opportunities available in wilderness. To evaluate the physical and biological effects of recreational use, especially those associated with camping and trail use, managers can draw from a large body of research. However, little work has been done to develop efficient, accurate techniques for monitoring social conditions, despite the important role these play in the visitor's wilderness experience.

The Forest Service has recognized the need to provide opportunities for solitude in the wildernesses it manages. Most Forest Plans with a wilderness management component single out the number of encounters wilderness visitors have with others as one of the two primary indicators of the opportunity for solitude. Generally, Forest Plans establish a standard for the maximum number of encounters one should have per day. The other commonly used social indicator addresses the opportunity available for solitude at campsites, and typically is assessed through counts of the number of other camps within sight or sound of each other. The standards for these two indicators are designed to reflect a range of opportunities from very pristine to "semi-primitive," and vary across a small number of opportunity classes. For example, in the Forest Service's Pacific Northwest region, standards require that there be "an 80% probability that visitors will have no more than 10 encounters per day" in areas designated to provide a "semi-primitive" opportunity, while one should meet no more than one other party per day in "pristine" areas. Campsite standards are more stringent, reflecting visitors' greater concerns for privacy at their camps. For example, in the Pacific Northwest Region, one should be able to see no more than two other camps in semi-primitive areas, and none in pristine areas.

Forest Service managers have begun to encounter problems as they have moved to implement their standards for solitude. A standard requiring an "80% probability of no more than 10 encounters per day" may sound good on paper, but poses numerous challenges in implementation (Parker 1992). First, the definition of "an encounter" is not self-evident, and many nuances are left undefined in the Forest Plans. Second, methodologies for measuring encounters (as opposed to measuring use) are virtually nonexistent or untested. Finally, little is known about the variability in encounter rates, and therefore about the sample sizes and sampling regimes required for valid inferences about typical wilderness experiences.

This study was designed to address these three problems -- defining encounters, measuring encounters, and sampling requirements -- and make recommendations to managers about how best to monitor encounters. It begins with discussion of the three areas of concern and a review of research. It then presents five methods developed and tested in 1991. It concludes with suggestions for wilderness managers.

REVIEW OF RESEARCH

A. Defining encounters

One of the major reasons for the lack of implementation of encounter standards is the difficulty in defining "an encounter." Unlike physical resource conditions, encounters between parties are inherently subjective and transient experiences, and many managers have expressed reluctance to commit themselves to a rigid and therefore somewhat contrived definition. Nevertheless, a standardized, quantifiable definition is a prerequisite to attempts to monitor encounters.

In the rare cases that encounters have been defined at all, the definitions have not been consistent. At its most inclusive, an encounter is considered to be any visual or audible contact between members of one group and members of another group. In a more restrictive sense, only immediate contact between groups passing on a trail is considered to be an encounter, while glimpses of distant groups are not. Both extremes have been employed in Forest Service monitoring. Some have argued, probably correctly, that there is a qualitative difference between encountering others closely on a trail and briefly glimpsing someone off in the distance. Thus, an unresolved question concerns whether there should be separate records kept for each of the various types of encounters.

Considerable debate has also centered around whether one should measure encounters in terms of the number of groups or in terms of the number of individuals met. A common objection to counting groups is the difficulty in determining who belongs to which group. Much of the survey research done has used the terminology "groups" or, more vaguely, "parties," but it is not clear whether people find the number of individuals or the number of groups met more salient. Some research has suggested that people object more to meeting a few large groups than to several small groups. Questions phrased more generally result in each visitor imposing his or her own definition of an encounter, as when people are asked "how many parties did you meet during the day today?" In this question, "party" is not defined as referring to people or to groups. Forest Service managers currently monitoring encounters typically count both the number of individuals and the number of groups, but interpret Forest Plan standards to refer to group-group contacts. Research should be designed to determine whether people care more about the total number of people or the total number of groups they meet.

In addition to specifying whether groups, individuals, or both should be counted, monitoring should include components of location and time (Shelby and Heberlein 1986). Most research has used the day as the unit of time for encounters (Manning and Ciali 1980; Hammitt, McDonald and Noe 1984), although some river research has used the trip as the unit of time (Shelby 1980). Occasional studies question respondents about the actual and appropriate length of time that occurs between encounters (University of Vermont 1979), while others have posed questions in terms of the percentage of time respondents were within sight of others (Shelby et al. 1987; Lee 1977). The appropriate unit of time (day, hour, or trip) seems to be determined in part by the actual number of encounters, so that at high levels of encounters, shorter time blocks are more meaningful and manageable to respondents. Management standards for encounters are almost universally set for the number of groups and/or people seen (and sometimes heard) per day. One difficulty with these standards is their failure to specify the length of a day. Because the "day" of a dayhiker may be much shorter than the day of an overnight camper, comparing the absolute number of encounters may be difficult.

Research has contributed to identifying the psychologically relevant features of encounters. The number, type, and location of encounters contribute significantly to visitors' attitudes about the others they meet. Characteristics of the group encountered, such as the size of the group, mode of travel, and behavior of its members, have been explored (Lime 1977; Shelby 1980; Stankey 1980; West 1982). In general, small groups are preferred to large; similar mode of travel is preferred to different; and disruptive or distasteful behavior is more important to visitors than the actual number of encounters. Given the importance of these factors to visitors' experiences, designers of monitoring systems should consider incorporating them as variables (see Graefe, Vaske, and

Kuss 1984; Stankey and McCool 1984; Shelby and Heberlein 1984, 1986; Manning 1985; Shelby, Vaske, and Heberlein 1989).

Almost no research has addressed whether people subjectively evaluate trail encounters differently from encounters that occur off trails, or even what proportion of encounters occur on and off trails. Location is important to visitors: it is generally accepted that encounters on portal trails are evaluated less negatively than encounters at interior destinations. Similarly, encounters at campsites are evaluated much more negatively than encounters on trails (Stankey 1980). Therefore, one may hypothesize that encounters occurring off trails may be evaluated differently from those on trails. If so, this has bearing for managers in terms of the categories they use to collect information. Specifically, monitoring only trail encounters may ignore the more significant categories of encounters.

Another unanswered question concerns how to count groups encountered more than once. For example, sometimes each encounter with the same group is counted as a separate encounter (Shelby and Colvin 1982; Shelby et al. 1987). However, there is no information on how people feel about seeing one group several times versus seeing several different groups once each, or even how typical such encounters are.

B. Methods of measuring encounters

The overall intent of monitoring encounters is to find measures that reliably relate to visitors' experiences. Methods have been developed to measure actual encounters - that is, out in the wilderness using agency personnel or trained observers. Where the intent is to use encounters as an indicator for solitude, actual encounter rates of trained observers are less relevant than visitors' own perceptions of their encounters. Direct counts may be useful only to the extent that they are related to perceived encounters. Thus, survey researchers typically question visitors after their trip about their encounters with others. Questioning people results in perceived, not actual, encounter rates, for a variety of reasons. Encounters may not be salient to some visitors, who are therefore inattentive and report inaccurately, or people may not recall the number of other groups they met when that number is very high. The important thing is how a visitor feels about the number of others he or she perceives or remembers meeting during a wilderness trip; thus, if one does not recall meeting anyone, one achieved a high level of solitude, regardless of whether one actually saw others.

Some attempts have been made to predice encounters indirectly. Indirect measures of encounters rely on some form of predictor, such as measures of use, that can be correlated with perceived encounters.

Measuring perceived encounters

Reported encounter data have typically been obtained through mail and on-site questionnaires, on-site interviews, and self-issue diaries (Heberlein and Vaske 1977; Lee 1977; Absher and Lee 1981; Bultena et al. 1981; Stankey 1973, 1980; Hammitt et al. 1984; Lucas 1985; Hammitt and Maddes 1989; McCool and Brathewaite 1990; Lime 1991). Sampling methods have included systematic or random samples of permit-holders (Roggenbuck, Watson, and Stankey 1982; Brown and Haas 1980; Shelby et al. 1989) and samples of all users present on randomly or systematically chosen days or locations (University of Vermont 1979; Manning and Ciali 1980; Stankey 1980; Absher and Lee 1981; Roggenbuck et al. 1991).

Using reported encounters as a measurement tool can have a number of advantages besides providing the most accurate assessment of visitors' wilderness experience. Where a permit or registration system is in use, samples of visitors for a mail survey can be easily obtained and stratified by variables of interest. Fully representative samples can be obtained in this way, and large samples require little additional expense. Few of the other monitoring methods so easily allow confident inference to the entire population of wilderness visitors. On-site interviews or questionnaires can provide a great deal of information at relatively low cost, especially at high-use trailheads. Some wildernesses have volunteer hosts stationed at such trailheads during the summer who can administer a questionnaire or informal interview (see Schomaker and Lime 1986). Wilderness rangers can also be used to elicit information from visitors on site. For example, rangers in the Desolation Wilderness in California posed ten questions to a proportion of all groups they encountered in the wilderness. This method required only a few minutes per interview and generated over 400 interviews during the course of the season (Chilman 1986, 1990). On-site methods may be inappropriate, however, at lightly used trailheads, because of the amount of time necessary to obtain an adequate sample.

Surveys administered outside wilderness are less intrusive than those that require contact within wilderness. For managers concerned about infringing on visitors' wilderness experiences, this may be an important consideration. Finally, surveys offer the advantage of providing a tool to obtain a great deal more information about visitors than just the number of other people they met during their trip.

Surveys have some disadvantages, however. First, managers of federal wildernesses must obtain clearance from the Office of Management and Budget to conduct any sort of survey. There may also be considerable cost involved, in printing, mailing, or providing personnel to administer questionnaires on-site.

Surveys administered at trailheads require someone to be available for a considerable number of days if managers desire to obtain a representative sample of conditions across an entire season.

Trip diaries have been issued to wilderness visitors as to measure encounters. Diary-keepers record their travel routes, campsite locations, and trail and camp encounters. Lime (1972, 1977, 1991) has used this method several times in the Boundary Waters Canoe Area Wilderness, with a response rate of nearly 80% in 1971. Diaries have also been issued to river trips (McCool, Lime, and Andersen 1977; Shelby and Colvin 1982) and in Yosemite (Shechter and Lucas 1978). In Mt. McKinley, visitors were not issued a diary, but were requested ahead of time to keep track of the number of other groups seen each day during their trips (Bultena et al. 1981). Aside from printing and postage, this method costs relatively little, especially where a system is already in place for contacting wilderness visitors (such as a permit system or trailhead host). However, return rates may be low, and inter-party consistency in method and diligence may be quite variable. Also, it is unclear how comparable these respondents who have been primed to pay attention are to other visitors who have not been primed. There is some degree of imposition on visitors, although perhaps less than occurs when contacting them personally in the backcountry or when an observer accompanies groups.

Indirect predictors of encounters

In addition to various survey options, one may be able to make use of the relationship between use levels and encounters as an indirect measure of encounters. A number of techniques exist to measure the number of people present in an area, such as trailhead counters, pressure plates, movie cameras, mandatory permits, or voluntary registration cards. If encounters are a function of use, then measuring use may give an acceptable approximation of encounters. However, the relationship between use levels and encounters is believed to be quite variable (Shelby 1980; Bultena et al. 1981). Shelby and Heberlein (1986) reported a correlation of .71 between river contacts per day and use on the Rogue River, and .68 between the number of contacts per day and use in the Grand Canyon. These studies report river usage, which may well differ from wilderness hiking because travel patterns are more complex on trails than on rivers. In areas where the correlation between use and encounters is high, it may suffice to infer encounters indirectly by monitoring use levels. However, if these relationships vary across areas, the relationship must be established independently for each area. Attempts have been made to use computer models of travel patterns to refine the relationships (Shechter and Lucas 1978), but these are not widely in use. Measures of use require validation (for example, determination of compliance rates for permits), and some mechanical devices require periodic maintenance. The greatest potential benefit of this indirect method seems to be for low use areas, where other methods may be prohibitively costly and where some degree of error will not affect the overall interpretation of results.

Direct measures of encounters

Few attempts have been made to monitor encounters directly. Trained observers can obtain a great deal more information on the objective nature of encounters than can be acquired in any other way. For example, they can record specifics of location, duration, characteristics of groups, and behavior. Such information can help refine the evaluation of encounters at specific locations.

Probably the most common direct measure of encounters is done by wilderness rangers, who report the number of groups and people they meet during their regular work patrols. However, rangers in different wildernesses use different variations of this method and record different sets of information, so the method is poorly defined and inconsistent. For example, in Three Sisters Wilderness, rangers have historically recorded the number of people they encounter on trails, their mode of travel, and non-conforming behaviors, but have not recorded groups seen off the trail as encounters unless the people were occupying a campsite. Similar methods, with local variations, are reported for the Selway-Bitterroot and Mt. Shasta Wildernesses, and undoubtedly are in widespread use in other areas.

Despite flaws in current use of wilderness rangers, observation by wilderness rangers has many potential benefits. It poses little additional cost to wilderness management because rangers can incorporate encounter monitoring into preexisting duties. Rangers can be trained to employ uniform techniques, and can gather more information than just the number of encounters. It also requires no disturbance of wilderness visitors.

The disadvantages of relying on rangers are primarily the possibility of inadequate sample sizes, bias toward high-use times and places, and potential differences between the travel and encounter patterns of wilderness rangers and "typical" visitors. For example, Shechter and Lucas (1978) reported that wilderness rangers in their study traveled on average one-third again as fast as recreational visitors, despite making no effort to hurry. Rangers commonly spend most of their time in heavily-used or problem areas and may only visit low-use areas a few times per year, which precludes obtaining adequately large samples from many areas. Additionally, it is common for rangers to travel through several different opportunity class zones during the day, which clouds the interpretation of the data they collect. For example, can one draw reliable conclusions from two hours of observations in each of three or four zones? Can we be confident that such a short period will reflect the experiences of the typical visitor? These problems have been noted but not systematically explored in research.

Trained observers have been used in various studies to record encounters. Absher and Lee (1981), for example, had observers repeatedly travel multi-day loops in Yosemite National Park. Trained observers have accompanied river trips to record encounters. In two studies (Shelby 1980; Shelby and Colvin 1982), observers accompanied Grand Canyon and Rogue River float trips, keeping detailed itineraries of travel and recording all encounters with boat and shore parties. A problem in using trained observers is the high investment of time required for adequate sampling, especially in low-use areas. Often it is not practical (or even possible) to send someone out to walk trails all summer, especially when complete coverage of all areas is desired. However, in high-use areas with few miles of trail, systematic trail travel may be possible. Volunteers could profitably be used to perform such monitoring. The major disadvantage of this method is the possibility of differences between the experiences of trained observers and wilderness visitors. If trained observers report significantly different encounter rates than other wilderness visitors, their encounters may not be a good indicator of the wilderness experience.

Trained observers and wilderness rangers have also collected information on camp encounters. Heberlein and Dunwiddie (1979) observed campsite selection and occupancy for 61 campsites over 33 days. Among other information gathered, they determined for each night how close people camped to others and how many other occupied sites were visible from each camp. On 34 nights during 1990, wilderness rangers in Three Sisters Wilderness recorded which sites at one high use destination were occupied. Knowledge of which sites were visible from others later allowed calculation of how many groups camped within sight or sound of one another on each night. A similar method is reported in Absher and Lee (1981). In regularly-patrolled areas with good vantage points and clustered campsites, this is a useful and relatively low-cost technique. As employed by Heberlein and Dunwiddie (where the observer watched each group arrive and set up camp), the demands on time can be considerable. However, as used in Three Sisters Wilderness, it required only an hour each evening, and was combined with regular patrol duties. For the method to be accurate, observers must interpret campsite maps in a consistent fashion. In areas with large numbers of closely spaced sites, early season training is required to ensure consistency. In addition to being relatively easy to implement, this method provides valuable information about camping patterns and campsite preferences.

Comparability among methods

Each of these various direct and indirect methods has been used to monitor encounters. However, the question remains: which are most efficient in which contexts, and how comparable are the results generated? In wildernesses where one wished to combine methods of encounter monitoring -- a likely prospect for financially-limited wilderness managers -- one might face the problem of inconsistencies between methods. For instance, managers might want to use information from their rangers who regularly patrol certain high use areas, but might choose to use a survey or diary for other areas not so frequently patrolled. One would not know whether any observed differences obtained from the different methods were reflections of real differences in the number of encounters or simply differences in recall or accuracy. For example, wilderness rangers might really have more encounters than typical visitors to a given area, or they might simply have better recall at high levels of encounters. Interpreting the results and comparing between areas could become problematic in such situations. Even more difficult would be comparing the objective conditions in different wildernesses, if different monitoring methods are used in each.

In one of the only comparisons of diary, reported, and actual encounters, Shelby and Colvin (1982) had one volunteer from each of 41 Illinois River float groups fill out a diary during their trip. At the end of the trip, all members completed a short survey asking about encounters. Results were used to compare diary and reported encounters. In a counterpart study on the Rogue River, trained observers who accompanied trips were used to evaluate the difference between actual and reported encounters. Shelby and Colvin concluded that diaries did not vary much from reported encounters, but both tended to underestimate the number of actual encounters. At levels above about six encounters per day, floaters underreported the actual number of encounters by about half. However, when actual contacts were below six, reports were fairly accurate. In a similar study, Shechter and Lucas (1978) investigated the correlation between backcountry campers' reports of the number of other groups camped near their own and the number recorded by wilderness rangers for the same camps. Rangers reported, on average, one-third more camping groups present than did visitors. These two cases indicate that accuracy may vary depending on the number of groups encountered and the method used to monitor.

Sampling concerns

Almost no attention has been devoted to the timing of sampling or to the sample sizes required to evaluate compliance with Forest Plan standards. For example, in the Bob Marshall Wilderness, compliance with standards is evaluated by dividing the total number of days rangers met more than the standard number of parties by the number of days sampled, with no provision made for small samples or non-representative sampling. Furthermore, there is no discussion of how to handle variations in the amount of time spent observing each day, so that a short day may be within standard simply by virtue of being short (Bob Marshall Wilderness Monitoring Guidebook, 1988). These failings are by no means unique to the Bob Marshall Wilderness. Often, reports of the "average" number of parties met do not include discussions of how many weekdays versus weekends were sampled, how many hours were sampled per day, and for survey research, how many people were surveyed on each sample day. Encounter rates are known to be highly variable and to differ substantially between weekdays and weekends. Therefore, large samples are probably required to obtain a precise estimate of "typical" encounter rates. Where managers are trying to manage for the probability of a certain number of encounters, precision is required.

OBJECTIVES OF THE STUDY

One of the first steps to developing workable techniques for monitoring encounters is to test various methods simultaneously, in order to compare their results, precision, and relative merits under uniform conditions. Another is to ascertain which are most appropriate in which contexts. For example, some methods may be more efficient for small, heavily used areas while others are more appropriate for large, low-use areas. Another major concern for managers is the amount of time required to generate statistically valid conclusions about encounter levels. How much time do rangers need to spend patrolling? How many hours should they spend in a given area each day, and how many days each year? If questionnaires are to be used, how many people must be surveyed? Should all members of the group be asked to report encounters, or just a single representative? Given these needs and questions, we designed a study which employed a variety of encounter-monitoring methods simultaneously at a single wilderness destination. Results can be compared for accuracy and similarity, and to determine sampling needs. Specific questions to be explored included:

1. What are the relative merits and costs of each method tested - diaries, post-trip on-site surveys, mail surveys, wilderness ranger reports, and trained observers - in terms of money, time, efficiency, and data quality?
2. What encounter rates are generated by each method?
3. How can these results be used to evaluate compliance with Forest Service standards for encounters?
4. What is the relationship between use level and encounters as measured by each method? Are there indirect ways to predict encounter levels or perceptions of encounter levels at various points within a wilderness using direct counts of the number of people present (use level)?
5. How much variability is there between areas in the relationship between use and encounters?
6. What is the relationship between actual and reported encounters?
7. How much observation time is required to obtain reliable estimates of typical encounter rates?

METHODS

A. Study areas

Research was conducted during 1991 in Mount Jefferson and Three Sisters Wildernesses in Oregon, at three high-use destinations. In Three Sisters, the Sunshine Meadows-Obsidian Falls area is a popular, subalpine area (ranging from 6000 to 6800 feet), with spectacular views of the North and Middle Sisters. Many people hike the pleasant and moderately strenuous 11-mile loop in and out of the area. Half of the more than 1,100 groups visiting the area in 1991 were overnight visitors. Virtually all of the visitors to the area enter and leave through a single trailhead, with most of the remainder entering through two other trailheads.

Green Lakes lie at 6500 feet, on the southeast flank of the South Sister, just over four miles from the closest trailhead. The lakes are surrounded by open pumice flats, with bands and clumps of conifers separated by meadows and sandy expanses. This is the most popular area in Three Sisters Wilderness, and use is increasing rapidly. Approximately 2,300 groups (over 6,400 people) entered the area through Green Lakes trailhead in 1991, less than one-quarter of whom camped overnight in the wilderness. Although Green Lakes trailhead is the primary entry point for visitors to Green Lakes, many visitors arrive at the area from one of half a dozen other trailheads.

Marion Lake, which sported a boathouse and other structures prior to its inclusion in Mt. Jefferson Wilderness in the early 1970s , is an easy 2.5 mile walk from Marion trailhead. Because of the topography, virtually all visitors enter and depart through this one trailhead. The 360-acre lake is the most popular destination in the wilderness for anglers and families. At 4100 feet, Marion Lake lies in dense large old-growth forest on the west side of the Cascade range. Just over half of the 1,400 groups visiting the lake in 1991 were day users.

B. Methods of data collection

1. Encounters:

Five methods for monitoring inter-party encounters were employed at Obsidian Falls in Three Sisters 1991: (i) on-site surveys of day and overnight visitors; (ii) mailback surveys sent to samples of overnight and day visitors; (iii) trip diaries issued to overnight parties entering the wilderness through the main trailhead; (iv) wilderness ranger reports; and (v) trained observers from Oregon State University (see Table 1). Each of these methods was evaluated for ease of implementation, cost to implement at a sufficient level, and quality of the information gathered. All methods were compared to determine similarities and differences in results obtained when use levels were held constant. Perfoming each method simultaneously was necessary to determine the relationships between the results obtained by each. If each method was done at a different time during the summer, any observed differences could be attributable to the time of the monitoring, rather than inherent differences in the methods. Although all methods were used concurrently on sample days, no visitor was asked to undertake more than one of the surveys, so there was no confounding of responses.

At Green Lakes in Three Sisters and Marion Lake in Mount Jefferson the on-site questionnaire, mailback surveys and wilderness rangers were used (Table 1). Diaries and trained observers were used at Marion Lake (but not at Green Lakes). However, sample sizes were so small for these methods at Marion Lake that the data are not analyzed here.

Table 1. Methods used to monitor encounters

method	Obsidian	Marion	Green Lakes
trailhead survey	yes	yes	yes
mail survey	yes	yes	yes
diary	yes	(insufficient)	no
wilderness rangers	yes	yes	yes
trained observers	yes	(insufficient)	no

i.) Trailhead questionnaires.

A three-page questionnaire was distributed to all visitors leaving the wilderness through Marion Lake, Green Lakes, and Obsidian trailheads on a sample of weekdays and weekends over the course of the summer. The questionnaire was designed to serve the needs of two research projects; therefore, questions about encounters comprised only one part. Day users were asked to report the length of time they spent in the wilderness and the number of other parties (total number of groups and total number of people) they saw on the way into the wilderness and the way out. Overnight visitors were asked to report the number of groups and people seen during each of the final two days of their trip, where they spent each day and camped, and the number of other groups camped within sight or sound of them on the last night. The questions were worded in two parts: "How many groups and people did you come within speaking distance of during the day?" and, "How many other groups and people did you see but not come within speaking distance of during the day?" Splitting the question this way was done to serve the needs of Willamette National Forest managers, who wished to monitor the encounters people have on trails separately from those off trail. Therefore, it was necessary to ask people to divide number of people they met into those that occurred within speaking distance (on trails) and those seen in the distance (off trail).

At Obsidian Falls and Green Lakes, surveys were administered on randomly sampled days (stratified by weekday and weekend/holiday). Stratification by weekday versus weekend was done to ensure that data on encounters would be obtained across a full spectrum of use and encounter levels. At Obsidian Falls, this resulted in 18 weekdays and 11 weekend/holidays. At Green lakes, surveys were administered on 16 weekdays and 7 weekend days. Marion Lake trailhead was added to the study at the last moment, so sampling was by convenience, although effort was made to sample across the days of the week. Researchers were present at Marion trailhead on 9 weekdays and 9 weekend days. At Marion Lake and Obsidian trailheads, surveys were administered by Oregon State University personnel. All groups leaving the wilderness were approached, and all party members were asked to complete the questionnaire. At Green Lakes, surveys were administered by a Forest Service wilderness ranger; most, but not all, groups were approached, and not all members completed surveys.

ii.) Wilderness Rangers

Wilderness rangers patrolled the three study areas intensively during 1991, with more consistent coverage on weekends. They also patrolled all other high-use destinations with less intensity. The Willamette and Deschutes National Forests have among the highest levels of staffing in the Pacific northwest; approximately 25 full-time seasonal rangers were responsible for all of Mt. Jefferson and Three Sisters Wildernesses (over 350,000 acres in total). This permitted the high level of presence maintained in the study areas. Rangers were expected to seek out and contact most groups present in their work areas in order to obtain information about compliance with new wilderness permit regulations. Two pocket-sized notebooks were designed and printed on waterproof paper, one for recording trail encounters and compliance and one for recording which campsites were occupied. Rangers kept a detailed record of their daily patrols, including the time they arrived and left each destination and the time they spent hiking each trail. For each party encountered, they recorded the following information:
*the time of day;
*the location of the encounter;
*the number of people, horses, and/or dogs in the party;

*whether the party encountered was on or off a system trail;
*whether the party consisted of day visitors or was staying overnight;
*whether the ranger had encountered the group before, and, if so, when;
*the direction the group was traveling;
*whether the ranger contacted the group;
*wilderness permit information:
    -whether the group had a permit;
    -whether the dates of travel on the permit were correct;
    -whether the itinerary specified on the permit was correct;
    -whether the group left the required copy of the permit at the trailhead.

In the campsite occupancy data book, rangers made an entry each time they observed a camp. On nights they camped in the study area, they checked all sites and recorded the administrative numbers assigned to all occupied sites. For each group camping, they recorded the number of people, horses, and/or dogs in the party, whether they had encountered the group before (and if so, when), permit compliance information, and the number of other groups camped within sight or sound.

iii.) Mailback surveys

Mailback questionnaires were sent to systematic samples of all visitors who obtained permits for Mt. Jefferson, Mt. Washington, and Three Sisters Wildernesses. Because Marion Lake, Green Lakes, and Obsidian Falls represent a significant proportion of wilderness use, reasonably large samples were obtained from these areas. The 15-page questionnaire contained encounter questions similar to those on the trailhead questionnaire. From day users, 36 responses were obtained from Marion Lake, 23 from Obsidian Falls, and 69 from Green Lakes. Fewer overnight visitors were sampled for the mail survey: 14 respondents were from Marion Lake, 10 from Obsidian Falls, and 10 from Green Lakes.

iv.) Trained observers

Trained observers monitored encounters directly at Obsidian Falls, and to a lesser extent, at Marion Lake. This method was not used at Green Lakes. On days when a researcher was present at the trailhead to administer surveys, the other researcher traveled through the area in a fashion considered typical of recreational visitors. This was done by hiking either slightly ahead or slightly behind a group of visitors and recording all parties met during the day. At Obsidian Falls, trained observers traveled some or all of the 11-mile loop trail, and at Marion Lake they traveled some or all of the 5-mile round-trip to and from Marion Lake. For each party they observed, the following information was recorded:

- the time and location of the encounter;
- the duration of the encounter (amount of time in sight and amount of time in speaking distance);
- the number of people, horses, and/or dogs in the party;
- the direction the party was traveling;
- whether the group was on or off the trail; if off the trail, how far;
- whether the group consisted of day users or overnight visitors;
- disruptive or illegal behaviors;
- the nature of the contact (friendly, indifferent, etc.)
- whether the researcher had seen this group before, and if so, when.

Like wilderness rangers, OSU researchers recorded all occupied campsites and the number of people at them, as well as the number of other camps visible or audible from each occupied site.

v.) Trip diaries

All overnight parties entering the wilderness on days when a researcher was present at Marion and Obsidian trailheads were approached and asked to carry and complete a diary during their trip. Parties agreeing to do so received approximately five minutes of instructions prior to leaving the trailhead. The diary contained a map, instructions, and blocks for recording the date and time they hiked each trail segment. For each trail segment, respondents were asked to record the number of hiking parties (groups and people) and horseback parties (groups and people) they either came within speaking distance of or saw in the distance. Respondents indicated their camp locations on the map, and reported the number of other camps within sight or sound of theirs. They also reported the number of people who passed by their camp while they were there. Groups were given a stamped, addressed envelope in which to return their diaries. No effort was made to elicit responses from those failing to return the diaries on their own.

2. Shadowing:

The five methods described above were used to obtain actual encounter rates (trained observers and wilderness rangers) and perceived encounters (surveys and diaries), but did not directly address the relationship between the two. In order to assess the relationship between actual and reported encounters, Oregon State University researchers "shadowed" 47 groups (114 people) at Obsidian Falls and 12 groups (28 people) at Marion Lake. When "shadowing," the researcher typically left the trailhead just ahead of a party about to enter the wilderness, and stayed ahead of the group to the first trail junction (3.4 miles at Obsidian Falls, and 1.2 miles at Marion Lake). In some cases, the researcher approached the group at this point and asked all party members to complete a short questionnaire concerning the number of groups and people they had met since they left the trailhead. In other cases, the researcher continued to shadow the group until later in the day. The researcher kept track of all groups and people encountered during the shadow period; this number was inferred to be the actual number of encounters had by the shadowed party. Generally, the first party entering the wilderness after the research team arrived at the trailhead in the morning was selected for shadowing. The length of time spent shadowing an individual group ranged from 0.5 hours to 7.0 hours, with an average of 2.3 hours.

3. Use levels:

In order to evaluate the feasibility of indirectly predicting encounters from use, it was necessary to obtain accurate estimates of the number of groups and people present in each study area on days when encounter data were recorded. Controlling for use was also necessary for contrasting the different methods of encounter monitoring, because samples were often collected on different days for each method. For example, wilderness ranger data were collected for 55 different days at Obsidian Falls, whereas survey data were gathered from 80 overnight groups on 27 different days, from 65 day parties on 27 different days, and from 64 trained observers on 49 different days. Trained observers and wilderness rangers had more observations from low-use days than survey respondents. Conversely, more survey data were obtained for high use days, because the number of respondents surveyed greatly exceeded the number of wilderness rangers and OSU personnel present on these days. This imbalance in design is countered by controlling for use level in comparing results obtained by each method.

Daily use levels for each of the three study areas were derived from wilderness permits and site-specific compliance information collected by wilderness rangers. Wilderness permits were required of all parties visiting Mt. Jefferson, Three Sisters, and Mt. Washington Wildernesses from May 31 to October 31, 1991. Day users obtained permits from self-issue boxes at all trailheads, and overnight visitors were required to obtain permits from Forest

Service offices or cooperating retail outlets. Visitors were asked to report their travel plans as specifically as possible on the permit.

Two forms of use data were calculated for each study area. The first consisted of the number of people and groups entering the trailhead on each calendar day. This was computed by summing the number of permits for each day and dividing this total by the seasonal compliance rate of visitors to the area. This gave the most accurate estimate possible of the true number of people and groups present within the area by calendar day. The second form of use data consisted of the number of groups and people actually present in the study area on each calendar day. The number of permits showing plans to visit each study area were totaled by calendar day. Overnight groups were counted as present in the area on the days they entered and left the wilderness, regardless of what time they departed or returned.

Because compliance may have varied day-to-day within a single area, the use figures contain some error. Based on between 200 and 400 groups checked for permits in each of the three study areas, the seasonal compliance rates were 75% at Marion Lake, 88% at Obsidian Falls, and 83% at Green Lakes. The maximum number of groups present on any given day within the study areas was calculated to be 63 (235 people) at Marion Lake, 59 (173 people) at Obsidian Falls, and 88 (263 people) at Green Lakes.

RESULTS AND DISCUSSION

1. *Response rates, data quality, and costs*

With the exception of wilderness ranger data, the methods used to monitor encounters required a considerable investment of time and sophisticated statistical analysis. The methods varied considerably in terms of data quality and representativeness.

i.) *Trailhead questionnaires.* At Marion Lake and Obsidian Falls, three-quarters of all people leaving the wilderness while researchers were present completed the three-page questionnaire (see Table 2). At Green Lakes, due to the trailhead design, the sheer number of people entering and leaving the trailhead, and the wilderness ranger's other duties, not all people were contacted, and response rates were not computed. Nevertheless, the ranger strove to obtain at least one completed questionnaire from each party. A small percentage of parties were given the questionnaire to mail back later. Seventy person-days (8 hours each) were required to obtain a total of 1,149 surveys from the three areas.

TABLE 2. Trailhead Questionnaires

	Study Location		
	Obsidian	Marion	Green Lks.
# weekdays sampled	18	9	16
# weekends sampled	11	9	7
total	29	18	23
% visitors completing questionnaire	74	75	not available
# surveys returned			
day	137	183	341
overnight	197	178	123
total	324	361	464

Despite the high response rates to most questions, many visitors did not completely answer our questions about encounters. Between 5 and 28% of all respondents left either all of the questions about the number of groups met or all of the questions about the number of people met completely unanswered. Tables 3 and 4 display competion rates for questions: Table 3 presents responses rates for questions about the number of groups met; Table 4 presents response rates for questions about the number of people met. The questions were complex, asking day users to divide encounters into those that occurred on the way into the wilderness from those that occurred on the way out of the wilderness, to separate encounters that occurred within speaking distance from those that did not, and to report the number of groups encountered as well as the number of people. Overnight visitors were asked to report encounters in the same way as day visitors, but only for the last two days of their trip. This complexity may have deterred respondents from answering the questions. People were observed to take time considering these responses, and several groups apparently left it up to one member of the party to report the encounter information. (For questions about the number of groups met, between 62 and 80% of groups had at least one completed questionnaire, whereas only between 49 and 66% of the total number of individuals completed these questions).

TABLE 3 - RESPONSES TO QUESTIONS ABOUT THE NUMBER OF GROUPS MET

	Obsidian		Marion Lake		Green Lakes*	
	over	day	over	day	over	day
Percent of respondents....						
completing all "groups" questions	62	65	60	49	66	54
partially answering "group" questions	17	27	20	42	6	34
answering none of the "groups" questions	22	9	20	9	28	12
Percent of groups in which at least one member completed all "groups" questions	79	78	79	62	77	80

* The question on Green Lakes' surveys asked about encounters specifically at Green Lakes; Some visitors did not go to Green Lakes, and their responses are not included here.

TABLE 4 - RESPONSES TO QUESTIONS ABOUT THE NUMBER OF PEOPLE MET

	Obsidian		Marion Lake		Green Lakes*	
	over	day	over	day	over	day
Percent of respondents....						
completing all "people" questions	77	73	70	52	78	65
partially answering "people" questions	11	22	19	44	12	30
answering none of the "people" questions	12	5	11	5	10	5

* The question on Green Lakes' surveys asked about encounters specifically at Green Lakes; Some visitors did not go to Green Lakes, and their responses are not included here..

The length of the questionnaire and its administration at the end of a trip may have contributed to the low responses on encounter questions. Support for this contention is found in the high (over 90%) response to the shorter "shadow" form, which asked only encounter questions and which was administered in the wilderness during a rest break.

Many respondents answered either the questions about the number of groups encountered *or* the questions about the number of people encountered, but not both. As is evident from a comparison of table 3 and table 4, respondents from all three study sites completed the questions about "number of people seen" significantly more often than those about the "number of groups seen" (Mantel-Haentzel test, p<.0001). The improvement in response ranged from three percentage points (for Green Lakes overnight visitors) to 15 percentage points (for Obsidian overnight visitors). This is consistent with the often-voiced argument that it can be difficult to determine to which group people belong, especially when many people are present in an area. Furthermore, it suggests that, for wildernesses with this amount of use, questions designed to elicit encounter information should be worded in terms of the number of people met, not the number of groups met.

Examination of tables 3 and 4 also indicates that overnight visitors were more likely to complete encounter questions than were day visitors.

The trailhead surveys generated substantial data from high use days, and it almost certainly would not be necessary to have an interviewer present at the trailhead for a full day to generate sufficiently large samples on high use days. For example, an interviewer present during a few hours on a Sunday afternoon would catch most people leaving the wilderness. However, on low-use days, trailhead surveys were less efficient. Often, interviewers waited at the trailhead until dark in hopes of obtaining a single response. Other methods, or even inferences based on the number of permits, may be more appropriate for low-use times or trailheads.

Although we asked all members of each group to complete our questionnaire, in the following analysis, only one respondent per group was selected to represent the encounter rate of the group. We could not use all the responses from members of the same group, because their responses are not independent of each other. Such lack of independence would invalidate the use of inferential statistics.

ii.)*Wilderness rangers*. Wilderness rangers generally did a high quality job recording encounter data, although some rangers were more conscientious than others. All attended a one-hour training session early in the season. Some rangers initially misinterpreted instructions, but these problems were usually corrected by early season trouble-shooting. To rely effectively on wilderness rangers, one must plan and carry out field checks. All the data from one ranger district (fortunately not within the study areas) were essentially unusable because of a fundamental misunderstanding that could easily have been rectified. If simpler wilderness ranger methods are used elsewhere, such extensive training and quality control might not be necessary.

Wilderness rangers recorded a considerable base of usable data, distributed across weekdays and weekends throughout the season (Table 5). The greatest problem with their efforts was their occasional failure to record beginning or, more commonly, ending times for observation periods. This invalidated the data from 18 days of observatons, because without these times, encounters could not be standardized for comparison with other methods.

TABLE 5. WILDERNESS RANGER DATA COLLECTION - TRAVELING ENCOUNTERS

	Marion	Green Lks	Obsidian
number of days of data collection			
weekends	15	7	24
weekdays	28	7	31
total	43	14	55
number of days not used because of errors in recording	12	6	0

Wilderness rangers also collected campsite occupancy data. The quality of these data varied more than the trail encounter information. During 1991, rangers at Marion Lake were the most thorough in checking all camps at the lake each afternoon or evening. At Green Lakes and Obsidian Falls, coverage was less complete, and rangers typically failed to record which camps they had not checked. Because these two areas are so large, it was typical for them to check only a portion of the sites each night. These problems were addressed during training in 1992, and data from the second summer are more complete for all areas. Data from both years are included in the analysis here.

Table 6 presents the number of days that rangers present in each of the study area recorded which campsites were occupied and which were not. For each camp observed, they recorded the number of other groups camping within sight or sound.

TABLE 6. WILDERNESS RANGER DATA COLLECTION - CAMPSITES

	Marion	Green Lks	Obsidian
Number of weekdays	14	16	25
Number of weekend days	19	16	28
Total number of days campsites were checked	33	32	53
Total number of occupied campsites observed	132	238	392

iii.)*Trained observers*. Oregon State University researchers were present at Obsidian Falls on 49 different days. As might be expected, all data from these trained observers were of high quality, with no major recording errors. Despite the number of days spent recording encounters in each area, trained observers were not as effective at recording occupied sites as were the wilderness rangers. Often, trained observers passed through the study areas mid-day, before groups had set up camps. Furthermore, they were less familiar with the campsite locations than were the wilderness rangers.

iv.)*Diaries*. The diary return rate was lower at Marion Lake (39%) than at Obsidian Falls (55%). Of the 49 diaries issued at Marion trailhead, only 19 were returned, therefore these data are not analyzed. At Obsidian Falls, diaries provided encounter information from 43 different days with a full spectrum of use levels. The costs of diaries were relatively low. Aside from photocopying and postage, the major cost was the time spent at trailheads. However, the amount of information obtained per diary was much greater than the amount obtained per visitor survey, because diary data were kept for several days by each group. The poor results from Marion Lake should not be interpreted to indicate a major problem with the method. Marion Lake visitors are known to be different in socio-demographic characteristics and attitudes than visitors to other areas. We believe the response by Obsidian Falls visitors was more typical of the responses we would receive in most parts of the wilderness.

v.)*Mailback surveys*. Day users who responded to the mail questionnaire were more thorough in answering encounter questions than were respondents at trailheads. Of the 139 respondents, 92% answered all questions about the number of groups they met during their trip. Only three respondents failed to answer any of the encounters questions. There were no differences between mail respondents from the three study areas in terms of thoroughness. Thirty-four responses were received to the mail questionnaire from overnight visitors. These results are not analyzed here.

2. *What encounter rates were generated by each method?*

i.) Traveling encounters

We can characterize the mean encounter levels reported at each study location by each method. Tables 7-9 display summary statistics for encounters with other groups and people, as well as for the length of visits and the level of use within the study areas. Only respondents who stayed within the study area are included in this analysis, so that the summary statistics characterize conditions within a standardized area. For each method, we summed all the encounters the respondents had during the day (both within speaking distance and outside speaking distance). Encounters along access trails were included with encounters at destinations to give the total number of encounters per day. It was not possible to separate encounters along access trails from those at destinations because at Obsidian Falls (and to some extent at Green Lakes) there is no obvious "destination." Wilderness rangers, trained observers, and day users indicated the amount of time they spent in the wilderness, which was taken to be the length of their day. On diary forms, respondents recorded the time and location of all encounters. This allowed us to extract the encounters occurring just within the study area and determine the amount of time spent there for comparison with the other methods. The mail survey results in the tables refer only to day visitors, because the sample of overnight visitors from the three areas was quite small. Only data on the number of groups encountered and the length of stay were available for mail respondents.

For overnight parties, all encounters occurring on the final day of the trip were used. Because the survey did not ask visitors to distinguish between encounters occurring within the study area and those outside the area, we used only responses from groups that had camped in or near the study area the night before. This provision ensured that most or all of the encounters analyzed occurred in the study area. For overnight visitors, the number of groups and people met do not include the number of camps they saw. We computed the observation time for overnight visitors by arbitrarily assuming that their day began at 8 a.m. and ended at the time they returned to the trailhead (which was recorded by our staff).

The mean encounter levels presented in tables 7-9 are the mean number per trip, and do not take into account differences in lengths of trips by different types of visitors. The tables show that in some cases different users had different length observation periods or trips. Most notably, mail respondents reported being in the wilderness much longer than other visitors. The differences in trip length or observation period were not consistent across the study areas, although there was a tendency for overnight visitors to have longer days than day users.

The mean number of encounters reported in the tables also do not take into account differences in levels of use on sample days. The last four lines in Tables 7 and 9 indicate that there were significant differences in the mean use levels among the different methods. (Use data are not included for Marion Lake, because the day use permits were lost for a substantial number of the sample days.) "Groups present" and "people present" refer to the number of groups or people who were present in any part of the study area during any part of the sample day, while "groups entering" and "people entering" refer to the number of groups or people who entered the wilderness on the sample day through the study trailhead. (The use level for each day was weighted by the number of respondents on that day prior to calculating the mean use level. Thus, the mean use figures in the tables are weighted averages, not the simple average of use across sample days.) It is apparent that at Obsidian Falls and Green Lakes, overnight respondents were drawn from a population of visitors who experienced the highest use levels, while wilderness rangers and trained observers were from days with lower levels of use.

The differences in level of use and length of trip indicate that caution should be used in comparing group means directly. Because of this imbalance in design, regression analysis is a more appropriate tool to compare methods. This is done in the section below that discusses the relationship between use and encounters.

Despite this caveat, Tables 7-9 highlight apparent differences between monitoring methods and locations. In all three study area, overnight visitors experienced the lowest level of encounters, despite being sampled from days with higher levels of use and having longer stays. Overnight visitors' encounters were lowest at Marion Lake (mean 5.5 groups and 16 people), and greatest at Green Lakes (mean 10.5 groups and 32 people). Overnight visitors to Obsidian Falls had intermediate levels of encounters, with a mean of 7.2 groups and 22 people met on the last day of their trip.

The mean number of groups reported by day users who responded to the mail survey was higher in all three locations than the number reported at the trailhead, although the differences were not significant. It is interesting that respondents who were asked questions several weeks after the fact about their encounter rates on a specific trip appear not to differ substantially from respondents who were asked about their encounters immediately after their trip. If this inference is valid, mail surveys may be considered to generate results comparable to those of trailhead surveys. However, this interpretation should not be accepted uncritically, given that we have not determined whether the sample of mail respondents was taken from days with use levels equivalent to those of the trailhead surveys. Furthermore, respondents to the mail survey reported staying in the wilderness significantly longer than respondents to the trailhead survey, which could conceivably have resulted in higher encounter levels. The relationship between the mail responses (for both day and overnight visitors) and trailhead responses deserves further investigation.

At Obsidian Falls, there were no significant differences between the mean number of groups or people met as determined by each monitoring method (Table 7). Encounter rates ranged from a low of 7.15 groups per trip for overnight visitors to 10.7 groups per trip for mailback respondents. The mean number of people met was quite consistent, ranging from 20 to 25. It is important to note, however, that the length of visitors' stays varied significantly between methods. More importantly, use levels were strikingly different depending on the method of monitoring used. These differences may have masked true differences in the number of encounters that would be elicited by each method if use level and length of stay were held constant.

At Green Lakes, the mean number of groups and people met by wilderness rangers was larger than, but not significantly different from, the means for any of the other methods. The differences in length of stay were more notable at Green Lakes than at the other two study areas, with day users having the shortest trips and mail respondents and wilderness rangers the longest. Use levels experienced by overnight respondents were significantly higher than those of day users, and were lowest for wilderness rangers.

At Marion Lake, the most notable tendency was for overnight visitors to have fewer encounters than all other respondents. Overnight respondents met an average of 5.5 groups per trip, compared to 9 to 11 for day users, mail respondents, and rangers. Mean trip lengths did not differ among methods in this case, and thus probably does not account for the difference in encounters.

Unfortunately, we do not know whether use levels differed among our samples. The findings from Green Lakes and Obsidian Falls suggest that they may have differed significantly.

Most of the use in these wildernesses occurs on weekends. Therefore, it is useful to examine encounter rates separately for weekdays and weekends. Table 10 displays the encounter rates for each method at each study area for weekends and weekdays. It also contrasts the level of use between weekends and weekdays in each location. Data from the mail survey are not included, because the day of the week was not available.

In every case, mean encounter rates are higher on weekends than on weekdays, in some cases by more than a factor of two (Table 10). These differences are highly significant for all methods at Obsidian Falls. At Marion Lake the differences between weekdays and weekends were significant for day users and wilderness rangers, but not for overnight visitors. At Green Lakes, the differences were significant for day users, but not for rangers. The lack of a significant difference between weekend and weekday encounters for rangers may be a reflection of the lack of a significant difference in use levels for these samples. The results for overnight visitors at Green Lakes are ambiguous, with no difference in the number of groups met, but a significant difference in the number of people met.

The mean number of groups met on weekends was quite similar across all methods at Obsidian Falls, ranging from 9.1 to 13.2. This corresponded to a mean number of people met ranging from 27 to 32. Table 11 indicates that the differences between methods were not significant at Obsidian Falls on weekends. At both Marion Lake and Green Lakes, overnight visitors met significantly fewer groups than day users or rangers on weekends, but differences between rangers and day users were not significant (Tables 12 and 13). The overnight results from Marion Lake and Green Lakes suggest that overnight visitors to these areas were able to avoid other groups more successfully on weekends than were day users, and thus had fewer encounters on the weekends. At Marion Lake, overnight visitors met approximately 5 groups per day on weekends, compared to 12 to 14 groups for rangers and day users. At Green Lakes, overnight visitors met approximately 12 groups per day on weekends, compared to 17 or 18 for rangers and day users.

Differences between methods in the number of groups met on weekdays were not significant in any of the three areas (Tables 11-13). The same was true for the number of people met, with the exception of Marion Lake. At Marion Lake, rangers reported meeting significantly more people on weekdays than did visitors. On weekdays at Obsidian Falls the average number of groups met ranged from 4.24 to 6.72 depending on method. These weekday means are quite close to the weekday values obtained at Marion Lake for the same methods, which ranged from 3.13 (for overnight) to 6.44 (for wilderness rangers). Green Lakes had higher encounter rates; means for weekdays there ranged from 8 to 11 groups met per weekday.

These results demonstrate that method of monitoring may affect the results obtained on weekends, but not on weekdays. The implication is that on low-use days, all respondents report similar numbers of encounters.

ii.) Campsite encounters

Wilderness rangers observed 785 camps in the three study areas to determine how many other camps were visible or audible from them. Of these, 393 were at Marion Lake, 252 were at Obsidian Falls, and 140 were at Green Lakes (Table 14). Comparable data were obtained from 241 overnight groups about the number of other groups camped within sight or sound of their camp on the last night of their trip. Diary keepers reported the same information for 80 nights camped within the Obsidian Falls study area. Diary keepers also reported the number of other groups that passed by their camps while they were present. The mean values in Table 14 indicate that the number of other camps visible varied at Obsidian Falls depending on the day of the week, with Fridays, Saturdays, and holidays having significantly higher means than the rest of the week. This finding was consistent across rangers, overnight visitors, and diary keepers at Obsidian, but was not observed at Green Lakes for either overnight visitors or rangers. At Marion Lake, the pattern of more camps within sight or sound on Fridays and Saturdays was apparent in rangers' reports, but not in those of overnight visitors.

At Obsidian Falls, rangers reported more other camps visible or audible than overnight campers on all days of the week, although this difference was significant only for Sunday-Thursday. At Green Lakes, exactly the opposite was true: overnight visitors reported higher numbers of other camps visible than did rangers, but the difference was only significant for Saturdays. At Marion Lake, rangers reported more other camps within sight or sound than overnight visitors on Fridays and Saturdays, but none of the differences were significant.

If we look at all three study areas, no clear pattern emerges of the relationship between rangers and overnight visitors in terms of camp encounters. However, the fact that the differences between means were mostly not significant suggests that there are no systematic tendencies for rangers and overnight visitors to differ in their assessments of the number of other camps visible or audible.

The only information we obtained about the number of groups that pass people in their camps came from diary keepers at Obsidian Falls. On average, diary keepers had 2.79 groups pass their camp on Saturdays and holidays and 1.14 on weekdays. These respondents met an average of approximately 13 groups on the trail on weekends, and approximately 7 groups on weekdays. Relatively speaking, then, the number of groups passing by a camp is roughly 20% of the number they met on the trail.

3. *How can these results be used to evaluate compliance with Forest Plan standards?*

In Region 6 of the Forest Service, standards have been set for the maximum number of groups one should meet per day on a wilderness trip and for the number of other camps that overnight visitors should be able to see or hear from their camp. In our three study areas, the trail encounter standard states that there should be an 80% probability of meeting no more than 10 other groups per day. There should also be an 80% probability that no more than two other camps are visible or audible from any given camp.

Interpreting the 80% clause is rather difficult. However, it is clear that encounter rates are much higher on weekends than weekdays, so we analyzed each separately for compliance with the standard. Substantial proportions of respondents in all locations and for all methods met more than 10 groups per trip on weekends (Table 15). Only overnight visitors at Marion Lake (of whom we had a small sample) appeared not to exceed this standard more than 10% of the time. The percentage of respondents who reported meeting more than 10 groups varied greatly with method. For example, wilderness rangers at Green Lakes reported more than 10 encounters 88% of the time they were patrolling on weekends, compared to 69% of day users and 38% of overnight users. Typically, overnight visitors were least likely to exceed meeting 10 groups per day in all three locations.

The differences between weekends and weekdays are notable. If we take the standard to mean that no more than 20% of respondents should meet more than 10 other groups, it is apparent that by all monitoring methods this standard is exceeded at Obsidian Falls on weekends. However, by all methods the standard is not exceeded on weekdays in the same location. Only at Green Lakes is it clearly the case that the standard is exceeded on weekdays, and there only for rangers and day users, but not for overnight visitors.

In each of the three study areas, Forest Plan standards specify that there should be an 80% probability that no more than two other groups should be camped within sight or sound of any other group. To evaluate this standard, we calculated the proportion of overnight respondents who reported having more than 2 other camps visible or audible. At Marion Lake, despite the large number of groups camping (up to 23 individual campsites occupied on the busiest Saturday night of 1991), only 18% of groups reported having more than 2 other groups camped within sight or sound. At Obsidian Falls, 21% of groups had more than two other groups visible or audible, and at Green Lakes, 34% of all groups had more than two other occupied campsites within sight or sound. The greater proportion of camps exceeding the Forest Plan standard at Obsidian Falls and Green Lakes - in spite of the smaller actual number of parties camping on any given night - probably reflects the terrain and forest types of each area. Marion Lake is located in dense forest, which provides considerable screening, while Obsidian Falls and Green Lakes are more open.

4. *What is the relationship between encounters and use levels?*

As evident from Tables 7-9, the mean use levels on sample days and the mean lengths of stay varied among the methods used to monitor encounters. Regression analysis allows more accurate comparison of the results obtained by each method when use and trip length are not constant. This analysis results in different conclusions than were reached on the basis of the data presented in Tables 7-9. Tables 7-9 suggest that encounter rates do not vary significantly across most methods of monitoring within a given study location. Regression, however, demonstrates that this is an artifact of the use levels that occurred on our sample days and (in some cases) of differences in length of stay.

Tables 16 and 17 present the results of regression for each method, in which the number of groups (or people) met per day was modeled as a function of the number of visitors present in the study area (or entering the trailhead) on that day and the length of the visitor's trip. Mail survey data are not included here, because the date of the trips were not available. Encounter data suffer severely from the problem of heteroscedasticity. That is, the variability in encounters increases as use increases and as the number of encounters increases. Therefore, the residual plots indicate clearly that transformation is required. The best model takes the form Log(encounters) = fn (Log(use)). Results for these regressions are found in Tables 16a and 17a. Transforming the data improves the R^2 and residuals in almost all cases. The following analysis is based on the transformed models.

At Obsidian Falls, use level was significantly related to encounters for all monitoring methods, regardless of whether use and encounters were measured in terms of people or groups (Table 16a). For all respondents except day users, the length of trip was also a significant predictor of encounters. The models are weakest for overnight visitors (where R^2 ranges from .11 to .29), and strongest for wilderness rangers and trained observers (where up to 61% of the variance in encounters is explained by use level and trip length). Models for day users and diary keepers have very similar R^2 values.

The regression coefficient for use in the models indicates the direct relationship between use and encounters. A coefficient of one would indicate a one-to-one relationship between the log of encounters and the log of use. In all models, it is clear that rangers and trained observers generally have larger regression coefficients for use than other respondents. The size of the regression coefficients for other monitoring methods varies depending on whether we measure use in terms of visitors present in the area or visitors entering the trailhead.

The low relationship between use and encounters for overnight visitors probably reflects the difference between their travel and that of other visitors or wilderness rangers. The overnight visitors we surveyed had typically spent the day at their destination, and only traveled the busy trail corridor once, compared to twice for day users. Therefore, it is not surprising that use explains more of the variance in day visitors' encounters and exerts a stronger influence on the number of encounters they have.

It is unclear why trip length is unrelated to encounters for day users at Obsidian Falls but is related to all other encounters. Interpretation is further confused by comparison with results from Green Lakes. At Green Lakes, trip length was a significant variable in the model for day users but not for overnight users.

The relationship between use and encounters for diary keepers at Obsidian Falls was intermediate between those of day and overnight visitors. The length of observation period was significantly related to their encounter levels. The reason for this difference between diary keepers and overnight visitors is unertain. We have no reason to think that diary keepers differed in their travel patterns from other overnight visitors. Therefore, the variables determining encounter rates should have been the same for both. The stronger relationship between encounters and use for diary keepers may suggest a priming effect, which predisposeded them to pay more attention to encounters than they might have otherwise.

As might be expected, wilderness rangers at Obsidian Falls had higher levels of encounters than visitors. The fact that trip length is significant in the model for rangers probably reflects their tendency to seek out visitors both along trails and at destinations.

Trained observers were most similar to wilderness rangers in terms of the strength of the model and the magnitude of the regression coefficient for use. This might have been expected, given that both were vigilant and shared a common definition of encounters. However, trained observers' travel patterns were intentionally like those of visitors, so we would expect their encounter rates to be most similar to those of day or overnight visitors (presuming attention to encounters and recall were the same). This expectation was not borne out; observers evidenced a stronger relationship between use and encounters than did visitors. If, in fact, their travel was essentially similar to visitors, the difference between their encounter rates and those of visitors may be due to greater attention to encounters or greater accuracy at higher levels of encounters. This suggests that "typical" visitors might have reported higher numbers of encounters if they had been prompted to pay special attention to encounters. (See the discussion below in the section on "shadowing" concerning the accuracy of recall.)

Results from Green Lakes and Marion Lake are not nearly so clear as those from Obsidian Falls and complicate our overall interpretation (Table 17a). At Green Lakes, use was a significant predictor of encounters for both day and overnight visitors, while length of stay was also significant for day users. Neither variable was significantly related to wilderness rangers' encounters, but we suspect that this may reflect our small sample of wilderness ranger observations. The R^2 values are larger for day users at Green Lakes than at Obsidian Falls, but smaller for overnight visitors. The regression coefficients for day users at Green Lakes are quite high, in some cases the largest of any model for any location.

At Marion Lake, length of trip and use level were related to wilderness rangers' encounters, and together accounted for approximately 60% of the variance in their encounters. Yet neither variable was related to encounters for day users or overnight visitors. (Observations from days with missing use data were excluded from this analysis.) This may be the result of the relatively low variability in use among our sample days at Marion Lake. However, it may also reflect the geography and visitor behavior at Marion Lake. Visitors tend to disperse around the large lake after the short hike from the trailhead. Many are fishermen, who seek seclusion. The dense forest and convoluted shoreline afford screening not available in the subalpine areas of Green Lakes and Obsidian Falls and therefore may have kept encounters down despite high use levels. Rangers, who seek out visitors, are therefore quite unlike visitors in encounter rates at Marion Lake.

Although use is clearly related to encounters in two of our three study locations, the low values of R^2 for visitors suggests that attempts to predict encounters from use (at least as measured in this study) will be only marginally effective. Other variables would have to be incorporated into the model if we wished to predict encounters from use. These three study locations represent very simple use patterns - each has one main access trail, and only visitors traveling within the study area were included in our analysis. Furthermore, our estimates of use levels are quite reliable, given the high compliance with the mandatory permit system. In a more complex system - for example, one with trail junctions or with poor use estimates - the relationships between use and encounters would be lower still.

The regression models in Tables 16a and 17a provide some insight into the question of whether one should examine encounters in terms of groups or people. The models using groups give consistently higher values of R^2 at Obsidian Falls (except for wilderness rangers). The improvements are greatest for day and overnight users. However, at Green lakes, models using people give higher R^2.

In most cases it did not matter whether we used visitors present or visitors entering in the model. In the few cases where this made a difference, visitors entering generated larger values of R^2.

5. *How much variability is there between areas?*

In contrasting the conditions in the three study areas, it is apparent that the mean encounter rates are higher at Green Lakes than at the other areas for all methods of monitoring. Depending on the method, the number of people met ranged from 16 to 32 at Marion Lake, to 20-25 at Obsidian Falls, to 32-43 at Green Lakes. Nevertheless, the difference among areas is less than one might expect based on the total use of these areas. More than twice as many groups visited Green Lakes during 1991 as visited either Obsidian Falls or Marion Lake.

At Marion Lake, no significant relationship was found between use level and the number of groups met for either day or overnight visitors. This may reflect any of a number of factors: 1) the range of use levels sampled at Marion Lake was much narrower than at the other two areas. 2) compliance was lower at Marion Lake, which might indicate that compliance was also more variable across days. This would cause greater errors in the Marion Lake use figures than in those of the other two areas. 3) All day use permits from Marion trailhead were lost or taken from the trailhead for 5 sample days in August. Data from these sample days were not included in the regression analysis. 4) Marion Lake is a very short distance from the trailhead, and once people arrive at the lake they tend to disperse around the shore and out into rafts. Given that the lake is nearly 3 miles in perimeter, it is possible that people simply have much greater variability in encounters depending on where they are around the lake. 5) Marion Lake, unlike subalpine Obsidian Falls and Green Lakes, is located in dense old-growth forest which tends to obstruct long-distance vision. It is quite possible to have more people around you yet see fewer of them than could happen at Obsidian Falls or Green Lakes. In contrast to visitors at Marion Lake, rangers' encounters were related to trip length and use level. This undoubtedly reflects their tendency to seek out visitors. This finding for rangers was consistent with findings at Obsidian Falls.

In all three areas, overnight visitors had the lowest encounter rates, and this difference was especially notable on weekends. Rangers appear to have the highest levels of encounters. Green Lakes data, where rangers' encounters were unrelated to use, might contradict this conclusion. However, we had only 14 observatons from rangers at this site, which may account for the insignificant results.

The importance of length of stay in determining encounters for visitors is not clear, because of the contradictory results obtained at Green Lakes and Obsidian Falls. It is clear, however, that length of observation period is significantly related to encounters for wilderness rangers and trained observers.

Despite these similarites among areas, the actual encounter levels are quite different in each area. The variability in the relationship between encounters and use levels depicted in Tables 16a and 17a suggests that the relationship must be established independently for each different use area.

Furthermore, the low correlation between survey-generated encounter rates and use levels (provided the encounter rates are correct) implies that it will be difficult to control the number of groups met through regulation of the number of people present in the area.

6. *What is the relationship between actual and reported encounters?*

The relationships between use and reported encounters discussed in previous sections raise certain questions about the comparability of methods and the reasons for differences among them. For example, do wilderness rangers have more encounters than visitors, or do visitors underreport the actual number of encounters they have? This question has relevance for managers who may want to combine methods in their monitoring plans. We investigated this question by "shadowing" wilderness visitors, recording the encounters they had, and then asking them to report on their encounters.

In regression of reported encounters on actual encounters, Marion Lake data did not prove to be significantly different from Obsidian Falls data, so the two are combined in the analysis below.

In the best model, the reported number of groups met is a function of the actual number of groups met, the time of the observation period, and respondent's confidence in his or her estimate of the number of groups met (as rated on a 5 point scale from very confident to not at all confident):

reported groups =

$$2.18 + .60\,(\text{actual groups}) - .28\,(\text{time}) - .41\,(\text{confidence})$$

$$R^2 = .63$$

In the model for people met, group size was also found to be significant:

reported people =

$$5.0 + .62 \text{ (actual people)} - .82 \text{ (time)} - 1.51 \text{ (confidence)} + .47 \text{ (group size)}$$

$$R^2 = .65$$

Interestingly, both time and confidence were negatively related to the number of groups or people reported. The coefficient for use is very similar for both models, .60 for groups and .62 for people. This means that for every additional group met, respondents reported meeting .6 additional groups. Equivalently, for every additional group respondents report meeting, they actually met 1.7 additional groups.

Respondents were found consistently to underreport the number of groups they met (Table 18). At actual encounter levels between 0 and 20 people met, 48% of respondents underreported encounters, 35% overreported encounters, and 17% were correct in their reports. When more than 20 people were actually encountered, 65% respondents underreported encounters, 23% overreported, and 13% were correct.

TABLE 18. Accuracy of visitors reports of encounters

	actual # groups met	
% respondents	0-20	>20
underreporting	48%	65%
overreporting	35%	23%
correct	17%	13%

The relationship between respondents' error in reporting and the number of groups they met is described by the following line:

$$[(\text{reported grps}) - (\text{actual grps})] = 1.3 - .44 \text{ (actual groups)} \qquad R^2 = .42$$

Thus, for every additional group encountered, the discrepancy between actual and reported encounters increases by .44.

In exploring the level of encounters at which accuracy tends to drop off, we found that at 8 or fewer groups met, the slope of the regression line is greater than or equal to .90. (A slope of 1.00 would represent perfect agreement between respondents and the trained observer's record of actual encounters.) When more than 8 groups are encountered, the slope drops to below .76. In terms of people met, when 30 or fewer people were encountered, the slope of the regression line is greater than or equal to .90. When more than 30 people were met, the slope drops to less than .82. Thus, on average, people accurately recall encounters when they meet 8 or fewer groups, 30 or fewer people.

7. *How much time should one spend to get an accurate estimate of encounter rates?*

Managers are understandably concerned about the amount of time needed to collect sufficient encounter data. Encounters are so variable across time and space that considerable effort is required to obtain an accurate estimate of the "typical" state of affairs. There are two questions related to the amount time required. First, how many hours must an observer be present each day to be able to predict the number she would have during a full day of observation? This is important, because most often standards are written in terms of the acceptable number of encounters per day. A ranger or observer hiking through an area in one or two hours may see no one simply as a matter of chance on a day when he or she would have met many groups in a full day. However, as we have seen, rangers' and possibly visitors' encounters increase with the amount of time they spend in the wilderness. Therefore, the length of the day is critical in determining the daily encounter rate.

Obviously, the most accurate estimate of a day's encounters would come from being present for a full day (however a "day" might be defined for management purposes). However, it may be possible to arrive at an acceptable estimate of that number based on a shorter observation time. The question, then, is one of determining the shortest time that gives an estimate of daily encounters that falls within acceptable levels of confidence. If, for example, four hours will suffice, then rangers could gather information from two different areas in a single working day.

The second question addresses the number of days of observation required to assess compliance with standards. Is it adequate to evaluate opportunities for solitude based on just a few monitoring trips a year? Can we determine the minimum number of days required?

To answer these questions, we analyzed data collected by wilderness rangers during regular work patrols at Obsidian Falls, the area for which we had the most comprehensive data. To answer the question of the number of hours required per day, we examined hourly data collected on days when rangers were present at least eight consecutive hours within the Obsidian Falls area. We asked the question, how much variation is there hour-to-hour in the number of encounters? How much is this variation reduced if we examine the data in two-hour blocks? In three-hour blocks? Reduction in variation was assessed as the decline in the coefficient of variation. For example, take the following data, collected on August 1, 1991:

9:00-10:00	4 groups met
10:00-11:00	7 groups met
11:00-12:00	1 group met
12:00-1:00	5 groups met
1:00-2:00	3 groups met
2:00-3:00	1 group met
3:00-4:00	2 groups met

Had this ranger been present at Obsidian Falls only between 10:00 and 11:00 a.m., she would have grossly overestimated the true number of encounters she would have had in an 8-hour day: 7 encounters/hour x 8 hours = 56 groups predicted for an 8-hour day based on one hour of observation, when in fact the true number encountered was 23. On the other hand, had she been present only from 2:00 to 4:00 p.m., she would have underestimated the actual number of encounters: (3 groups / 2 hours) x 4 = 12 groups predicted for 8 hours based on this observation period. In this case, using all consecutive one-hour blocks gives an average number of groups met per time block of 3.29, with a coefficient of variation of .67. Using all possible consecutive 2-hour blocks reduces the coefficient of variation to .44.

Figures 1 and 2 illustrate the reduction in the coefficients of variation as the length of observation time increases, based on data collected at Obsidian Falls for 16 days in 1991 and 16 days in 1992. For the very short times, the standard deviation is larger than the average number of groups met. This means the confidence limits for the actual number of encounters are very wide. By the time the observation period reaches 4 hours in length, the CV is usually less than half the value of the mean. Thus, for example, on a day when a ranger reported meeting 2 groups per hour based on 4 hours of observation, one could be over 80% certain that the true number of encounters he or she would have had in 8 hours was 16 or fewer. In most cases, lengthening the observation period beyond four hours does not appear to give much greater precision.

Thus, at a high use site like Obsidian Falls, where rangers averaged between 16 and 18 groups per day on weekends and holidays and 9 to 11 groups per day on weekdays, an observation period of 4-5 hours probably gives sufficient information to evaluate their daily encounter rates with an acceptable degree of precision. Conversely, observation periods of 1-2 hours are clearly inadequate.

To determine how many days of observations were required to evaluate whether there was "an 80% probability of meeting 10 or fewer groups per day," we examined wilderness ranger data from Green Lakes, Obsidian Falls, and Marion Lake. We examined weekends and weekdays separately, because of their obvious differences in use and encounters. The range in encounters was extreme, especially on weekends and holidays, as previously noted.

Despite these wide ranges, the mean daily number of groups per hour stabilizes relatively rapidly as the number of sample days increases. For weekends and holidays, the mean appears to stabilize in around 10 to 12 days; for weekdays, the mean stabilizes by about 5 days (see Figure 3). The coefficient of variation did not decrease as the number of days increased.

CONCLUSIONS

This research has suggested some answers to a number of questions concerning encounters and encounter monitorings. Five methods were developed and tested at Obsidian Falls in Three Sisters Wilderness in 1991: trained observers, wilderness ranger reports, trip diaries, trailhead questionnaires, and mail surveys. Three of these methods were also tested at Green Lakes in Three Sisters and Marion Lake in Mt. Jefferson.

Trained observers were found to be the most thorough and to have the lowest error rates of all the methods tested. However, the costs were quite high because they only obtained a single individual's encounters each day they were out. More problematic was the finding that, depending on how use is measured, trained observers have much higher encounter rates than other visitors for any given use level.

Wilderness rangers were able to generate overall high quality data, although the quality varied depending on the individual ranger. The rangers accomplished a number of other duties while monitoring encounters, making the additional costs of encounter monitoring quite low. Despite initial hesitancy among managers regarding the amount of time needed, rangers unanimously reported that there was no undue burden. This finding is consistent with Chilman's work with wilderness rangers in California (1986, 1990). However, regression analysis indicates that at any given use level, rangers have more encounters than day or overnight visitors. Rangers seemed to be most similar to trained observers. Rangers and trained observers had tighter relationships between use and encounters and larger regression coefficients for use. This probably results from greater attention to encounters and greater accuracy at higher levels of use. This creates a problem in inferring visitors' encounters from those of rangers. It may be possible to determine the relationship between rangers' reports and visitors' encounters direction, and then use rangers' reports to predict visitors' encounters. Certainly, though, one would not want to take rangers' encounters to be equivalent to those of visitors.

Visitors can be relied upon to provide information about encounters. In our study, overnight visitors were more likely to answer encounter questions, and all visitors preferred to answer questions about the number of people they met to questions about the number of groups they met. We considered it imperative to provide a succint, yet specific definition of "encounter," and would prefer to use a less complex set of questions were we to use this method again. It appears to be important to ask how long respondents spent in the wilderness, because in some cases this time is related to encounters. It is also important to ask people where they went in the wilderness, so that encounter levels can be examined on a site-specific basis. So little variation was found among the members of the same group that it is probably sufficient to ask a single member to report encounters. Moreover, it would be inappropriate to use responses from more than one member of the same group, because to do so would violate the assumption of independence among observations.

Trailhead surveys indicated that overnight visitors have lower encounter rates than day visitors. In fact, overnight visitors had consistently lower mean encounters than any other respondents. It makes intuitive sense that day users would have fewer encounters than overnight visitors, all other things being equal, because their travel is more concentrated on heavily used portal trails.

Our findings from shadowing suggested that below 8 groups or 30 people met, recollection of encounters is generally high, but that accuracy drops beyond that point. Therefore, managers should also exercise caution is comparing survey results to direct measures of encounters (as collected by wilderness rangers or trained observers) at high encounter levels.

Diaries are a useful, low-cost instrument for measuring encounters. Despite a low return rate (50% at Obsidian Falls), each diary provided from 2 to 5 days of site-specific encounter data. Our return rate was lower than those reported by Lime (1991), but this may be because we did not follow up on non-respondents. Additionally, Lime's respondents were visitors to the Boundary Waters Canoe Area, who had to obtain one of a limited number of permits for their trip. These visitors may be especially highly motivated. Diary encounter rates were more similar to those of day visitors than to wilderness rangers or trained observers, making them a more valid assessment of the visitor's experience. However, they had higher encounter rates at any given use level than overnight visitors. There is no reason to believe that diary keepers' experiences were objectively different from those of overnight visitors, as both were sampled from the same population. One might argue, therefore, that the higher rates of diary keepers reflect either (1) greater attention to encounters due to "priming" by the researcher at the trailhead, or (2) greater accuracy because they recorded encounters as they occurred.

Mail surveys generated good samples of day users. Our data suggest that encounter rates as determined by mail are not different from those obtained on trailhead surveys. However, this conclusion cannot be accepted until we verify that use levels were the same for both samples. If correct, this would be an important finding.

In terms of camp encounters, there was no systematic difference between overnight visitors, diary keepers, and wilderness rangers when day of week was held constant. This may indicate that rangers can be used reasonably reliably to assess the number of camp encounters overnight visitors have.

Studying three areas simultaneously greatly affected our conclusions. The variability across areas presents a challenge to trying to make consistent sense of our data. Studying only one area would have led to different conclusions. Absolute encounters differed between areas, with Green Lakes much higher than the other two areas. In areas where use was related to visitors' encounters (Obsidian Falls and Green lakes), the tendencies were the same: day users had more encounters than overnight users at the same use levels. However, Marion Lake data indicate that in some areas use is not a good predictor of encounters. Evidence from Marion Lake and Obsidian Falls strongly suggests that wilderness rangers have more encounters than visitors when use is the same. However, the lack of such a finding from Green Lakes reminds us that this may not always be so. Such differences among areas should serve to caution managers not to generalize too broadly from a few sites. They should be aware to the effects topography, vegetation, length of access trails, and visitor behavior can have on encounters.

Our analysis shows that weekdays and weekends are sufficiently different that they should be analyzed separately. Encounters are much higher on weekends than weekdays. Differences in results generated by each method are high on weekends, but not different on weekdays in any of our study areas. Differences among monitoring methods can arise in two ways: (1) there may be objective differences in the number of encounters visitors, rangers, and trained observers have; or (2) all respondents may have similar encounters, but different recall of the encounters. Our results from shadowing visitors suggests that the second possibility certainly accounts for some of the differences observed. Our finding of differences between methods on weekends (high use times) and no such differences on weekdays (low use times) support this conclusion. We would expect divergences among the findings from different methods to increase as encounters increase. Rangers record encounters throughout the day, so their accuracy is high. Overnight visitors, on the other hand, will experiences marked declines in recall above about 8 groups met. Therefore we would expect less of a discrepancy at low use times (weekdays) than at high use times (weekends).

References Cited

Absher, J. D. and R. G. Lee. 1981. Density as an incomplete cause of crowding in backcountry settings. *Leisure Science* 4(3):231-248.

Bob Marshall, Great Bear, and Scapegoat Wildernesses Monitoring Guidebook. 1988. USDA Forest Service, Flathead, Lolo, Helena, and Lewis and Clark National Forests.

Brown, P. J. and G. E. Haas. 1980. Wilderness recreation experiences: The Rawah case. *Journal* of *Leisure Research* 12:229-241.

Bultena, G. L., et al. 1981. Closing the gates: A study of backcountry use limitation at Mount McKinley National Park. Leisure Science 4(3):249-267.

Chilman, K. C. 1986. Designing a low-cost monitoring system for Desolation Wilderness, California. In Proceedings--National Wilderness Research Conference: Current Research. Fort Collins, Colorado, July 23-26, 1985. Gen. Tech Report INT-212. Ogden, Utah: USDA Forest Service, Intermountain Research Station.

Chilman K. C. et al. 1990. Monitoring social conditions on wildlands: Designing low-cost systems. In D. Lime (ed.) *Managing America's Enduring Wilderness Resource*. St. Paul, MN: University of Minnesota.

Graefe, A. R., J. J. Vaske, and F. R. Kuss. 1984. Social carrying capacity: an integration and synthesis of twenty years of research. *Leisure Science* 6(4):395-431.

Hammitt, W. E. and M. Madden. 1989. Cognitive dimensions of wilderness privacy: A field test and further explanation. *Leisure Science* 11:293-301.

Hammitt, W. E., C. D. McDonald, and F. P. Noe. 1984. Use level and encounters: Important variables of perceived crowding among nonspecialized recreationists. *Journal of Leisure Research* 16(1):1-8.

Heberlein, T. A. and P. Dunwiddie. 1979. Systematic observation of use levels, campsite selection and visitor characteristics at a high mountain lake. *Journal of Leisure Research* 11(4):307-316.

Heberlein, T. S. and J. Vaske. 1977. Crowding and visitor conflict on the Bois Brule River. Tech. Report WIS WRC 77-04. Madison, Wisconsin: University of Wisconsin, Water Resources Center.

Lee, R. G. 1977. Alone with others: the paradox of privacy in the wilderness. *Leisure Science* 1:3-19.

Lime, D. W. 1972. Large groups in the Boundary Waters Canoe Area - their numbers, characteristics, and impact. USDA Forest Service Research Note NC-142. St. Paul, MN: North Central Forest Experiment Station.

Lime, D. W. 1977. When the wilderness gets crowded...? *Naturalist* 28(4):2-7.

Lime, D. W. 1991. Procedures to monitor social conditions in the Boundary Waters Canoe Area Wilderness following the Limits of Acceptable Change (LAC) planning framework. Final report to the Superior National Forest.

Lucas, R. 1985. Recreation trends and management of the Bob Marshall Wilderness Complex. IN Proceedings, 1985 National Outdoor Recreation Trends Symposium II. Atlanta, GA: USDI National Park Service, Southeast Regional Office.

Manning, R. E. 1985. Crowding norms in backcountry settings: A review and synthesis. *Journal of Leisure Research* 17(2):75-89.

Manning, R. E. and C. P. Ciali. 1980. Recreation density and user satisfactions: A further exploration of the satisfaction model. *Journal of Leisure Research* 12:329-345.

McCool, S. F., D. W. Lime, and D. Anderson. 1977. Simulation modeling as a tool for managing river recreation. In Proceedings, River Recreation Management and Research Symposium. USDA Forest Service General Technical Report NC-28. St. Paul, MN: North Central Forest Experiment Station.

McCool, S. F., and A. Braithwaite. 1989. An estimate of backcountry day use of Glacier National Park. Unpublished report, School of Forestry, University of Montana, Missoula.

Parker, T. 1992. Wilderness management in the Forest Service: A critical assessment of the Limits of Acceptable Change planning process. Commonly experienced problems in developing indicators and monitoring programs. MS Thesis, University of Washington.

Roggenbuck, J., A. Watson, and G. Stankey. 1982. Wilderness management in the Southern Appalachians. *Southern Journal of Applied Forestry* 6:147-152.

Roggenbuck, J. et al. 1991. River float trip encounter norms: Questioning the use of the social norms concept. *Journal of Leisure Research* 23(2):133-153.

Shechter, M. and R. C. Lucas. 1978. *Simulation of wilderness use for park and wilderness management*. Baltimore: Johns Hopkins Press.

Schomaker, J. H. and D. W. Lime. 1986. Wilderness information specialists at portals: Information disseminators and gatherers. In Proceedings -- National Wilderness Research Conference: Current Research. Fort Collins, Colorado, July 23-26, 1985. Gen. Tech Report INT-212. Ogden, Utah: USDA Forest Service, Intermountain Research Station.

Shelby, B. 1980. Crowding models for backcountry recreation. *Land Economics* 56:43-55.

Shelby, B. and R. Colvin. 1982. Encounter measures in carrying capacity research: Actual, reported, and diary contacts. *Journal of Leisure Research* 13(4):350-360.

Shelby, B. and T. Heberlein. 1984. A conceptual framework for carrying capacity determination. *Leisure Science* 6(4):433-451.

Shelby, B. and T. Heberlein. 1986. *Carrying Capacity in Recreation Settings.* Corvallis, OR: Oregon State University Press.

Shindler, B. and B. Shelby. 1990. User assessment of ecological and social campsite attributes. Paper presented at conference workshop, "Defining wilderness quality." Colorado State University, Fort Collins, CO. April 1990.

Shelby, B., J. J. Vaske, and T. A. Heberlein. 1989. Comparative analysis of crowding in multiple locations: results from fifteen years of research. *Leisure Science* 11:269-291.

Shelby, B., D. Whittaker, R. Speaker, and E. Starkey. 1987. Social and ecological impacts of recreation use on the Deschutes River Scenic Waterway. Report to the Oregon Legislature.

Stankey, G. H. 1973. Visitor perception of wilderness recreation carrying capacity. Research Paper INT-142. Ogden, Utah: USDA Forest Service, Intermountain Research Station.

Stankey, G. H. 1980. A comparison of carrying capacity perceptions among visitors to two wildernesses. Research Paper INT-242. Ogden, Utah: USDA Forest Service, Intermountain Research Station.

Stankey, G. H. and S. F. McCool. 1984. Carrying capacity in recreational settings: evolution, appraisal, and application. *Leisure Science* 6(4):453-473.

University of Vermont, Recreational Management Program. 1979. Hikers' views of backcountry management. Burlington, VT: School of Natural Resources, University of Vermont.

West, P. 1982. Effects of user behavior on the perception of crowding in backcountry forest recreation. *Forest Science* 28:95-105.

TABLE 7.

Summary Statistics for Obsidian Falls

	Monitoring Method						
	day users (trailhead)	overnight (trailhead)	wilderness rangers	trained observers	diary keepers	mailback day users	ANOVA
n	65	80	72	64	111	23	
mean # groups met per trip	8.08	7.15	9.15	8.58	9.43	10.7	p=.15
mean # people met per trip	22.7	21.6	25.3	20.3	23.8	not avail.	p=.52
mean observation length (hours)	4.9^{ab}	5.9^{b}	5.4^{ab}	5.1^{ab}	4.8^{a}	8.1^{c}	p<.0001
# different sample days							
weekends	11	11	24	18	19		
weekdays	16	16	31	31	24		
total	27	27	55	49	43	not avail.	
# groups present[1]	26.5^{ab}	29.6^{ab}	23.2^{bc}	17.6^{c}	29.2^{a}	not avail.	p=.0001
# groups entering[2]	15.4^{b}	16.2^{b}	12.8^{ab}	10.4^{a}	15.3^{b}	not avail.	p=.003
# people present[1]	76^{b}	80^{b}	65^{ab}	48^{a}	81^{b}	not avail.	p<.0001
# people entering[2]	39^{b}	41^{b}	33^{ab}	27^{a}	39^{b}	not avail.	p=.002

1 Number of groups and people present in the Obsidian Falls study area on sample days. Obtained by correcting wilderness permit information for non-compliance. Use levels for each monitoring method are weighted for the number of responses per survey date.

2 Number of groups and people entering Obsidian trailhead on sample days. Mean values are weighted for the number of responses per survey date.

3 Letters indicate significant differences (Tukey classes, p<.05).

TABLE 8.

Summary Statistics for Marion Lake

	Monitoring Method				
	day users (trailhead)	overnight (trailhead)	wilderness rangers	mailback day users	ANOVA
n	51	71	44	36	
mean # grps/trip	10.8b	5.5a	9.3ab	11b	p=.002
mean # people/trip	29b	16a	32b	not avail.	p=.0004
mean observation length (hours)	5.0	5.8	5.7	7.3	p=.07
# different observation days				not avail.	
weekends	9	9	15	not avail.	
weekdays	7	9	28	not avail.	
total	16	18	43		

Letters indicate significant differences (Tukey classes, $p<.05$).

TABLE 9

Summary statistics for Green Lakes

Monitoring Method

	day users (trailhead)	overnight (trailhead)	wilderness rangers	mailback day users	ANOVA
n	115	56	15	69	
mean # grps/trip	12.9	10.5	15.1	13.3	p=.19
mean # people/trip	40	32	43	not avail.	p=.18
mean observation length (hours)	4.5a	5.2ab	6.2bc	6.2c	p=.004
# different observation days				not avail.	
weekends	7	6	7	not avail.	
weekdays	16	12	7	not avail.	
total	23	18	14		
# groups present[1]	42b	50a	37b	not avail.	p=.0009
# groups entering[2]	32ab	37a	24b	not avail.	p=.004
# people present[1]	124a	145b	130ab		p=.04
# people entering[2]	89	101	84		p=.054

[1] Number of groups and people present in the Obsidian Falls study area on sample days. Obtained by correcting wilderness permit information for non-compliance. Use levels for each monitoring method are weighted for the number of responses per survey date.

[2] Number of groups and people entering Obsidian trailhead on sample days. Mean values are weighted for the number of responses per survey date.

[3] Letters indicate significant differences (Tukey classes, p<.05).

TABLE 10
Weekend vs Weekday Encounters
Differences within method

	day	rangers	p	day	p	overnight	p	diary	p	observers	p
						OBSIDIAN FALLS					
groups met	WE	12.4	.0002	10.3	.0005	9.1	.0003	12.6	<.0001	13.2	<.0001
	WD	6.1		5.7		4.2		6.7		5.9	
people met	WE	33.8		26.9		27.6		31.2		31.4	
	WD	17.7	.0005	18.0	.051	13.6	.0001	16.9	<.0001	14.1	.0002
groups present	WE	31.3		36.0		37.8		40.7		27.0	
	WD	15.6	<.0001	16.4	<.0001	16.5	<.0001	18.5	<.0001	12.4	<.0001
groups entering	WE	16.9		21.2		21.0		21.4		16.3	
	WD	8.9	<.0001	8.9	<.0001	9.1	<.0001	9.7	<.0001	7.1	<.0001
						GREEN LAKES					
groups met	WE	18.4		17.2		11.6					
	WD	11.3	.15	10.5	.0001	8.1	.13				
people met	WE	50.6		55.8		36.6					
	WD	34.6	.30	28.6	<.0001	22.9	.01				
groups present	WE	40.9		58.7		59.4					
	WD	32.3	.46	30.5	<.0001	33.8	<.0001				
groups entering	WE	23.0		42.6		40.8					
	WD	26	.67	24.6	<.0001	27.8	<.0001				
						MARION LAKE					
groups met	WE	13.8		12.1		5.2					
	WD	6.4	<.0001	5.1	.05	3.1	.36				
people met	WE	45.5		32.6		17.7					
	WD	24.2	.005	11.2	.02	10.0	.24				

Methods: ranger = wilderness rangers; day = day use (trailhead survey); overnight = overnight users (trailhead survey); diary = diary keepers; observer = trained observers.

Day: WE = weekend; WD = weekday

Test: t-test.

TABLE 11

Weekend versus weekday encounters for Obsidian Falls: Differences between methods

Variable	Form	n	Week	mean	std. dev.	ANOVA	class
Groups met	ranger	35	weekend	12.4	8.71	p=.09	
	day users	34		10.3	5.88		
	overnight	47		9.1	6.86		
	diary	51		12.6	8.22		
	t. observer	23		13.2	8.47		
	ranger	37	weekday	6.1	4.55	p=.08	
	day users	31		5.7	3.97		
	overnight	33		4.2	3.04		
	diary	60		6.7	3.54		
	t. observer	42		5.9	4.80		
People met	ranger	35	weekend	33.8	23.9	p=.56	
	day users	35		26.9	17.77		
	overnight	46		27.6	18.42		
	diary	59		31.2	20.05		
	t. observer	23		31.4	21.67		
	ranger	37	weekday	17.7	13.08	p=.48	
	day users	32		18.0	19.1		
	overnight	34		13.6	9.01		
	diary	63		16.9	10.77		
	t.observer	41		14.1	12.93		
Groups present (use level)	ranger	35	weekend	16.9	10.01	p=.0001	ab
	day users	44		36.0	15.31		abc
	overnight	49		37.8	12.66		bc
	diary	59		40.7	9.08		c
	t. observer	23		27.0	14.66		a
	ranger	37	weekday	15.6	6.71	p=.002	ab
	day users	33		16.4	9.21		b
	overnight	34		16.5	5.37		b
	diary	63		18.5	7.32		b
	t. observer	42		12.4	7.19		a
People present (use level)	ranger	35	weekend	89.6	38.3	p=.0001	ab
	day users	44		104.8	42.8		bc
	overnight	49		106.4	35.3		bc
	diary	59		115.2	26.2		c
	t. observer	23		77.3	42.3		a
	ranger	37	weekday	41.2	20.5	p=.007	ab
	day users	33		43.5	26.0		ab
	overnight	34		41.2	16.5		ab
	diary	63		48.0	21.7		b
	t. observer	42		31.9	22.3		a

Form: monitoring method
Class: tukey, $p<.05$

TABLE 12
Weekend versus weekday encounters for Marion Lake: Differences between Methods

Variable	Form	n	Week	mean	Std. Dev.	ANOVA	tukey letter
Groups met	ranger	17	weekend	13.8	6.31	p<.0001	a
	day users	25		12.1	9.81		a
	overnight	51		5.2	6.10		b
	ranger	27	weekday	6.44	4.58	p=.16	
	day users	9		5.11	4.68		
	overnight	8		3.13	1.81		
People met	ranger	17	weekend	45.5	25.36	p<.0001	a
	day users	39		32.6	26.40		a
	overnight	59		17.7	20.48		b
	ranger	27	weekday	24.2	22.12	p=.04	
	day users	9		11.2	14.52		
	overnight	24		10.0	6.32		

TABLE 13
Weekend versus weekday encounters for Green Lakes: Differences between methods

Variable	Form	n	Week	mean	std.dev.	ANOVA	tukey letter
Groups met	ranger	8	weekend	18.4	9.83	p=.04	b
	day users	45		17.2	12.41		b
	overnight	39		11.6	8.11		a
	ranger	7	weekday	11.3	8.08	p=.31	
	day users	72		10.5	5.60		
	overnight	17		8.1	7.00		
People met	ranger	7	weekend	50.6	28.65	p=.04	ab
	day users	57		55.8	47.14		b
	overnight	47		36.6	22.02		a
	ranger	7	weekday	34.6	28.6	p=.28	
	day users	82		28.6	18.89		
	overnight	25		22.9	18.80		
Groups present (use level)	ranger	8	weekend	40.9	17.49	p=.002	b
	day users	60		58.7	14.5		a
	overnight	39		59.4	8.31		a
	ranger	8	weekday	32.3	11.37	p=.47	
	day users	86		30.5	12.20		
	overnight	25		33.8	12.70		
People present (use level)	ranger	7	weekend	152.4	81.17	p=.47	
	day users	60		172.9	48.22		
	overnight	50		166.5	37.48		
	ranger	7	weekday	107.1	49.30	p=.36	
	day users	86		90.5	40.30		
	overnight	25		102.5	55.43		

TABLE 14

Camp Encounters
(number of other camps within sight or sound)

Differences within methods

OBSIDIAN

method	sunday-thursday	friday	saturday/holiday	ANOVA	% > 2*
rangers	.89a	1.29a	1.94b	p<.0001	
(n)	(88)	(65)	(99)		
diaries (camps)	.49a	.63ab	1.30b	p=.007	
(grps passing)	1.48	.57	2.79	p=.04	
(n)	(45)	(8)	(27)		
overnight visitors	.47a	.67ab	1.75b	p=.01	21
(n)	(36)	(12)	(40)		

GREEN LKS

method	sunday-thursday	friday	saturday/holiday		% >2*
rangers	1.56	2.00	1.65	p=.48	
	(43)	(28)	(69)		
overnight visitors	1.75	4.00	3.18	p=.11	34
	(24)	(10)	(39)		

MARION LK

method	sunday-thursday	friday	saturday/holiday		% >2*
rangers	.89a	1.43b	1.36b	p=.008	
	(97)	(84)	(212)		
overnight visitors	1.21	1.27	1.10	p=.91	18
	(19)	(11)	(50)		

* percentage of visitors reporting having more than 2 other groups camping within sight or sound.

Differences among methods

location	day	Rangers	Overnight	Diaries	ANOVA
Obsidian Falls	sun-thur	.89	.47	.49	p=.04
	fri	1.29	.67	.63	p=.13
	sat/hol	1.94	1.75	1.30	p=.60
Green Lakes	sun-thur	1.56	1.75		p=.68
	fri	2.00	4.00		p=.06
	sat/hol	1.65	3.18		p=.001
Marion Lake	sun-thur	.89	1.21		p=.24
	fri	1.43	1.27		p=.76
	sat/hol	1.36	1.10		p=.23

TABLE 15

Compliance with Forest Plan Standards

location	form	% respondents meeting > 10 groups	
		weekend	weekday
Green Lakes	rangers	88%	43%
	day	69%	42%
	overnight	38%	12%
Marion Lake	rangers	65%	19%
	day	48%	22%
	overnight	10%	0
Obsidian Falls	rangers	51%	19%
	day	41%	13%
	overnight	28%	3%
	diary	55%	12%
	trained observer	61%	14%

TABLE 16
Relationship between Use and Encounters
OBSIDIAN FALLS

encounter measure (y)	Indirect predictors (x)			
	groups present	groups entering	people present	people entering
Wilderness Rangers				
groups, per day (R-square)	y=-3.45 + 1.02 hour + .31 x (.49)	y=-3.53 + 1.22 hour + .47 x (.51)		
people per day			y=-9.6 + 2.82 hour + .30 x (.54)	y=-9.12 + 3.61 hour + .44 x (.50)
Trailhead, day users				
groups, per day	y=2.74 + .20 x (.33)	y=3.19 + .32x (.32)		
people, per day			y=8.7 + .19 x (.20)	y=11.0 + .31 x (.15)
Trailhead, overnight users				
groups, per day	y=2.26 + .17 x (.15)	y= 1.60 + .34 x (.23)		
people, per day			y=-1.5 + 1.72 hours + .33 x (.23)	y=-.27 + 1.70 hour + .15 x (.19)
Trained observers				
groups, per day	y=-3.04 + .93 hour + .31 x (.50)	y= -2.03 + .85 hour + .60x (.42)		
people, per day			y=-7.3 + 2.25 hour + .33 x (.52)	y=-4.5 +2.14 hour + .51 x (.36)
Diaries				
groups, per day	y= .31 + .54 hour + .28 x (.22)	y= 1.49 + .56 hour + .35x (.21)		
people, per day			y=6.7 + 1.4 hour + .26x (.15)	y=6.68 + .21 x (.25)

TABLE 16a
Relationship between Use and Encounters
OBSIDIAN FALLS

encounter measure: log(y)

Indirect predictors: log(x)

	groups present	groups entering	people present	people entering
Wilderness rangers				
groups, per day (R-square)	log y=-.51+.12 hr+.64 log x (.55)	log y=-.07+.14 hr+.59 log x (.59)		
people per day			log y=-.96+.16 hr+.76 log x (.61)	log y=-.07+.19 hr+.61 log x (.60)
Trailhead, day users				
groups, per day	log y=.63 + .46 log x (.34)	log y=.34 + .06 log x (.42)		
people, per day			log y=1.0+ .46 log x (.23)	log y=.85+.58 log x (.24)
Trailhead, overnight users				
groups, per day	log y=-.03+.11 hr+.39 log x (.19)	log y= -.37 + .10 hr + .61 log x (.29)		
people, per day			log y=.80 +.12 hr+.32 log x (.11)	log y=-.10+.11 hr+.63 log x (.18)
Trained observers				
groups, per day	log y=-.43+.10 hr+.72 log x (.50)	log y= -.08+.10 hr+.72 log x (.49)		
people, per day			log y=-.52+.13 hour+.71 log x (.47)	log y=-.21+.13 hr+.73 log x (.44)
Diaries				
groups, per day	log y= .14+.05 hr+.56 log x (.31)	log y= .57+.05 hr+.53 log x (.32)		
people, per day			log y=.39 + .61 log x (.27)	log y=.84+.06 hr+.52 log x (.26)

TABLE 17
Relationship between Use and Encounters
GREEN LAKES

encounter measure (y)	Indirect predictors (x)			
	groups present	groups entering	people present	people entering
Wilderness Rangers				
groups, per day (R-square)	no significant variables	no significant variables		
people per day			no significant variables	no significant variables
Trailhead, day users				
groups, per day	y=-1.2 + 1.08 hour + .23 x (.25)	y=-1.38 + 1.11 hour + .31x (.26)		
people, per day			y=-21.8 + 3.80 hour + .36 x (.39)	y=-21.1 + 4.4hour + .47 x (.29)
Trailhead, overnight users				
groups, per day	y=2.38 + .17 x (.10)	y=2.94 + .23 x (.10)		
people, per day			y=3.32 + .20 x (.24)	y=6.52 + .26 x (.17)

MARION LAKE

Wilderness Rangers				
groups, per day (R-square)	y=-.59 + 1.10 hour + .16 x (.38)	y=1.25 + 1.45 hour (.28)		
Trailhead, day users				
groups, per day	no significant variables	no significant variables		
Trailhead, overnight users				
groups, per day	no significant variables	no significant variables		

TABLE 17a

Relationship between Use and Encounters

GREEN LAKES

encounter measure: log(y)

Indirect predictors: log(x)

	groups present	groups entering	people present	people entering
Wilderness Rangers				
groups, per day (R-square)	no significant variables	no significant variables		
people per day			no significant variables	no significant variables
Trailhead, day users				
groups, per day	$\log y=-.14+.08\,\mathrm{hr}+.60\log x$ (.32)	$\log y=.01+.09\,\mathrm{hr}+.59\log x$ (.35)		
people, per day			$\log y=-1.26+.12\,\mathrm{hr}+.88\log x$ (.47)	$\log y=-.66+.13\,\mathrm{hr}+.79\log x$ (.39)
Trailhead, overnight users				
groups, per day	$\log y=.34+.47\log x$ (.09)	$\log y=.67+.43\log x$ (.08)		
people, per day			$\log y=.80+.50\log x$ (.20)	$\log y=.25+.66\log x$ (.16)
MARION LAKE				
Wilderness rangers				
groups, per day (R-square)	$\log y=-.12+.15\,\mathrm{hr}+.46\log x$ (.60)	$\log y=.16+.14\,\mathrm{hr}+.45\log x$ (.58)		
Trailhead, day users				
groups, per day	no significant variables	no significant variables		
Trailhead, overnight users				
groups, per day	no significant variables	no significant variables		

1991 Wilderness Ranger Encounter Data

Decrease in Coefficients of Variation as number of hours of observation increases

---

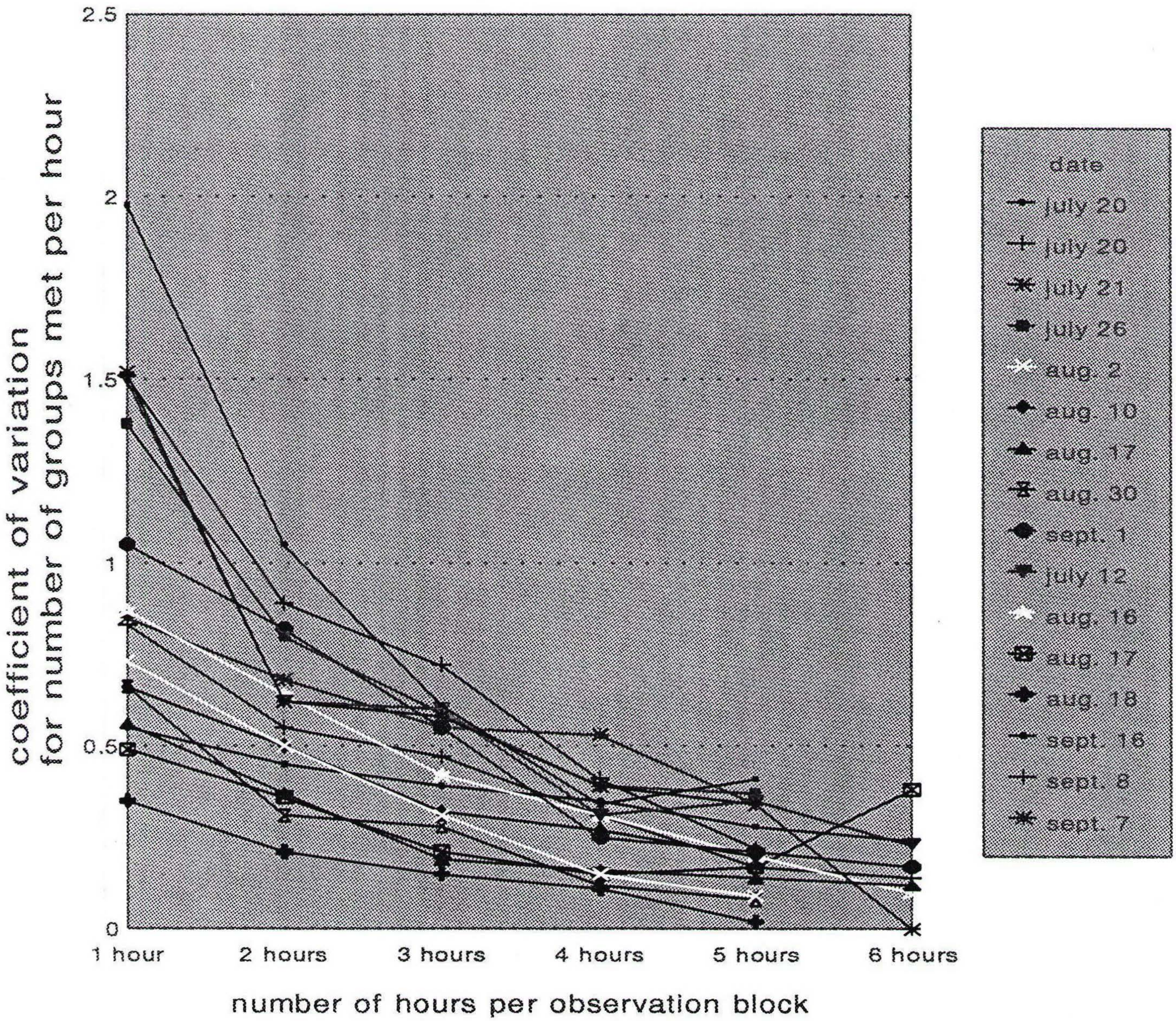

Figure 1

1992 Wilderness Ranger Encounter Data

Decrease in Coefficients of Variation as number of hous of observation increases

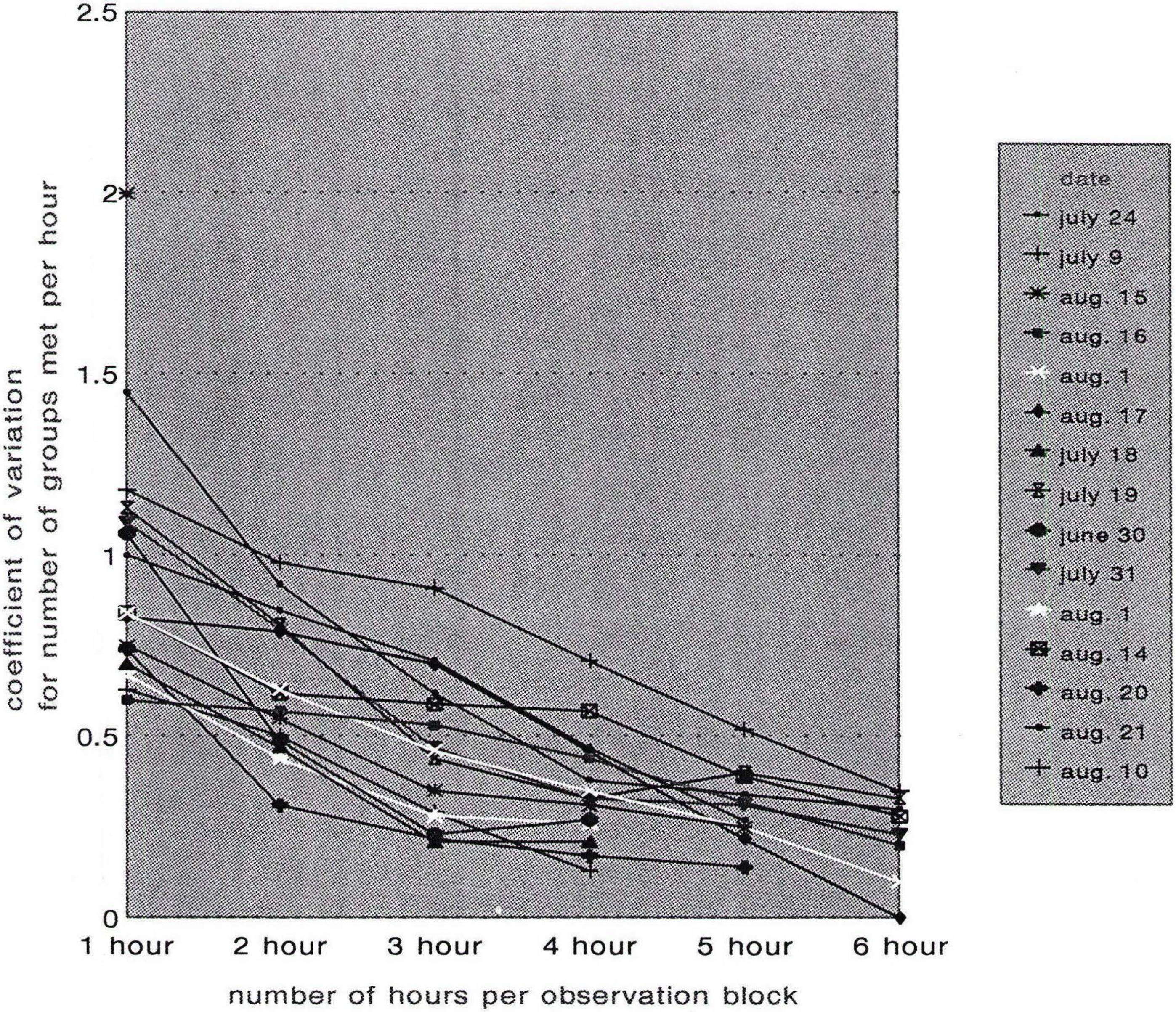

Figure 2

Effect of number of days of observation
on the average number of groups met per hour

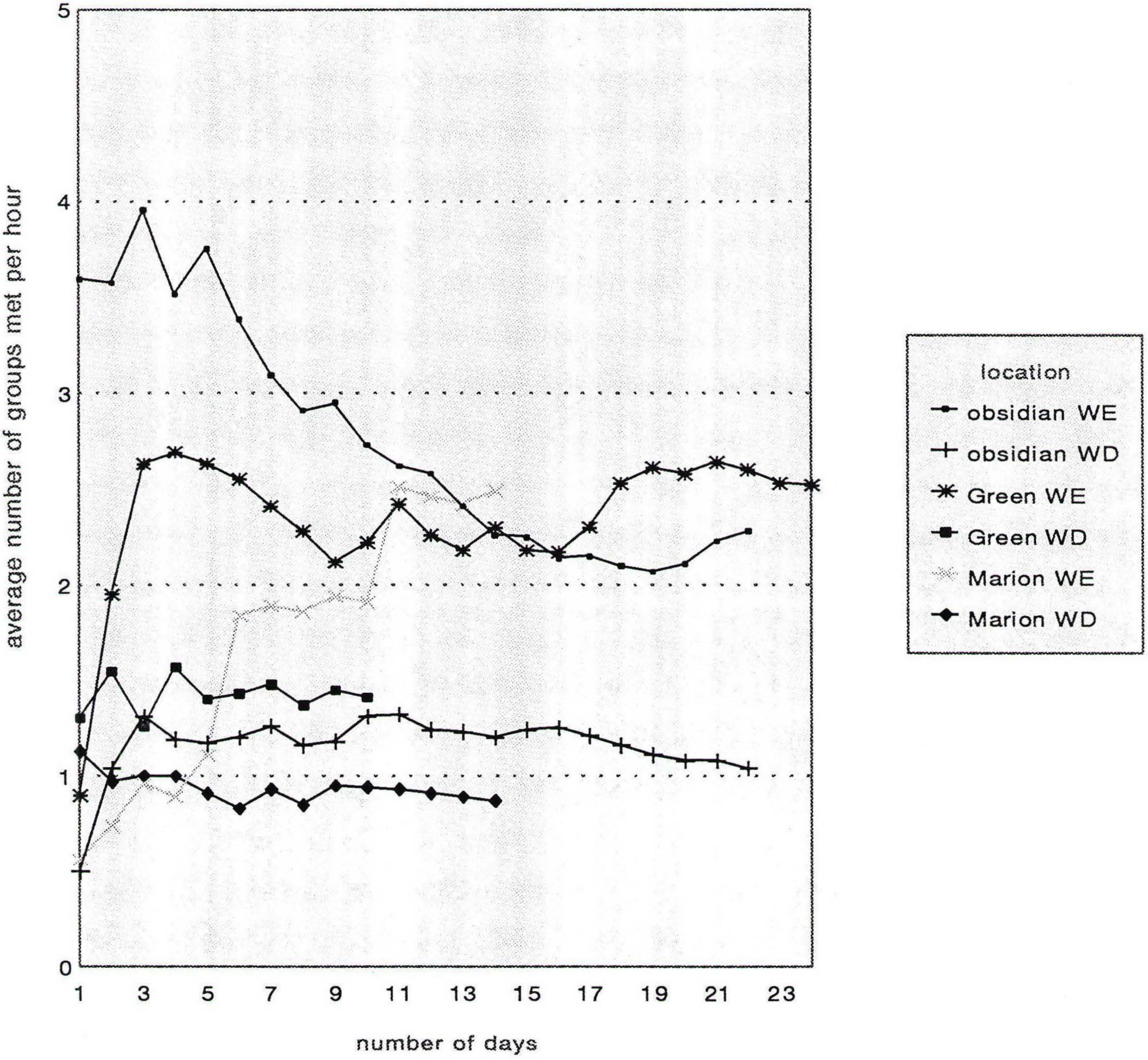

Figure 3